SAVITRIBAI PHULE PUNE UNIVERSITY

Board of Studies in Civil Engineering

Structure and Syllabus for B.E. Civil 2015 Course (w. e. f. June, 2018)

SAVITRIBAI PHULE PUNE UNIVERSITY

Board of Studies in Civil Engineering

Structure for B.E. Civil 2015 Course (w. e. f. June 2018)

	Semester-I										
Subject code	**Subject**	**Teaching Scheme Hrs/Week**			**In-Semester Assessment**	**TW**	**Pract /Or**	**End-Semester Exam**	**Total**	**Credit**	
		Lect	**Tu**	**Pr**						**Th**	**Lab**
401 001	Environmental Engineering II	3	--	2	30	--	50	70	150	3	1
401002	Transportation Engineering	3	--	2	30	50	--	70	150	3	1
401 003	Structural Design and Drawing III	4	--	2	30	--	50	70	150	4	1
401 004	Elective I	3	--	2	30	50	--	70	150	3	1
401 005	Elective II	3	--	--	30	--	--	70	100	3	--
401 006	Project (Phase-I)	--	2	--	--	--	50	--	50	--	2
Total :		16	2	8	150	100	150	350	750	16	6
										22 Credits	

	Semester-II										
Subject code	**Subject**	**Teaching Scheme Hrs/Week**			**In-Semester Assessment**	**TW**	**Or**	**End-Semester Exam**	**Total**	**Credit**	
		Lect	**Tu**	**Pr**						**Th**	**Pr**
401 007	Dams and Hydraulic Structures	3	--	2	30	--	50	70	150	3	1
401008	Quantity Surveying, Contracts and tenders	3	--	2	30	--	50	70	150	3	1
401 009	Elective III	3	--	2	30	50	--	70	150	3	1
401 010	Elective IV	3	--	2	30	50	--	70	150	3	1
401 006	Project	--	6	--	--	50	100	--	150	--	6
Total :		12	6	8	120	150	200	280	750	12	10
										22 Credits	

Following will be the list of electives.

Semester I

Elective-I 401 004	Elective-II 401 005
1. Structural Design of Bridges	1. Matrix Methods of Structural Analysis
2. Systems Approach in Civil Engineering	2. Integrated Water Resources Planning and Management
3. Advanced Concrete Technology	3. TQM & MIS in Civil Engineering
4. Architecture and Town Planning	4. Earthquake Engineering
5. Advanced Engineering Geology with Rock Mechanics	5. Advanced Geotechnical Engineering

Semester-II

Elective-III 401 009	Elective-IV 401 010
1. Advanced Structural Design	1. Construction Management
2. Statistical Analysis and Computational Methods in Civil Engineering	2. Advanced Transportation Engineering
3. Hydropower Engineering	3. Advanced foundation Engineering.
4. Air Pollution and control	4. Coastal Engineering
5. Finite Element Method in Civil Engineering	**5. Open Elective**
6. Airport and Bridge Engineering	a) Plumbing Engineering
	b) Green Building Technology
	c) Ferrocement Technology
	d) Sub sea Engineering
	e) Geoinformatics

Savitribai Phule Pune University, Pune

BE Civil 2015 Course

Syllabus

Semester-I

401 001 Environmental Engineering – II

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	**Paper In-sem : 30 Marks (1Hr.)**
Practical: 2 Hrs/week	**Paper End-sem : 70 Marks (2.5 Hrs.)**
	Oral : 50 Marks

Unit I **(6 Hrs.)**

Sewage quantity: Collection and conveyance of sewage, sources of sewage, variations in sewage flow, Flow quantity estimation (sewage and storm water quantification), design of storm water system, Design of circular sanitary sewers. Pumping of sewage, necessity, location. Effect of change of life style on sewage quality.

Characteristics of sewage: Methods of sampling, Physical, chemical and biological characteristics, Quality requirements for disposal and recycle/reuse of sewage as per CPCB norms.

Stream sanitation: Self-purification of natural streams, river classification as per MoEF & CC, Govt. of India; Oxygen Sag Curve, Streeter - Phelps equation and terminology (without derivation and numerical). National river cleaning plan.

Unit II **(6Hrs.)**

Sewage treatment: Pollution due to improper disposal of sewage, Introduction to sewage treatment, preliminary, primary, secondary and tertiary treatment, Unit operation and Process flow diagram for sewage treatment, Theory and design of screen chamber, Grit Chamber and Primary sedimentation tank as per the Manual of CPHEEO.

Unit III **(6 Hrs.)**

Theory & design of secondary treatment units: Introduction to unit operations and processes for secondary treatment. Principles of biological treatments, role of microorganism in wastewater treatment.

Activated sludge process: Theory and design of ASP, sludge volume index, sludge bulking & control, modifications in ASP. Operational problems and maintenance in ASP.
Concept of Sequential batch reactor (SBR) .

Trickling filter: Biological principle, different T.F media & their characteristics, design of standard rate and high rate filters using NRC formula, single stage & two stage filters, recirculation, ventilation, operational problems, control measures, theory of rotating biological contactors.

Unit IV **(6 Hrs.)**

Low cost treatment methods for rural areas

Oxidation pond: Bacteria – algae symbiosis, design of oxidation pond as per the manual of CPHEEO, advantages & disadvantages of oxidation ponds.

Aerated lagoons: Principle, aeration method, advantages & disadvantages of aerated Lagoons, design of aerated lagoon.

Introduction and theory of Phytoremediation technology for wastewater treatment. Introduction and theory of root zone cleaning system.

Unit V **(6 Hrs.)**

Onsite Sanitation Treatment systems: Septic tank**,** up-flow anaerobic filter. and Package Sewage Treatment Plant**-** Working principle, advantages and disadvantages. Introduction to MBR, MBBR and FMBR.

Anaerobic digester: Principle of anaerobic digestion, stages of digestion, bio – gas production its characteristics & application, factors governing anaerobic digestion,. Dewatering of sludge by gravity thickener, sludge drying bed, decanters. Methods of sludge treatment and disposal, advantages & disadvantages. Up-flow Anaerobic Sludge Blanket (UASB) Reactor– Principle, advantages & disadvantages.

Unit VI **(6 Hrs.)**

Industrial waste water treatment: Equalization and neutralization. Application of preliminary, primary and secondary treatment for industrial wastewater as per the CPCB norms.

Sources of waste water generation from manufacturing process, characteristics of effluent, different methods of treatment & disposal of effluent for the following industries: Sugar, dairy and distillery. Discharge standards as per CPCB norms.

Recycle & reuse of treated wastewater: Gardening, sewage farming, W.C. Flushing, reuse in industry.

Term Work:

A. Compulsory Assignment:

1. Brief report on Sewer materials, choice of materials, testing of sewer pipes, sewer appurtenances.
2. Design of septic tank.

B. Experiments:

The term work shall consist of a journal giving details of at least 8 out of 12 of the following experiments conducted in Environmental Engineering laboratory, of which, **Sr.No.12 is compulsory**.

Determination of

1. Solids -Total solids, suspended solids, volatile solids, settle able solids & non settle able solids.
2. Sludge Volume Index.
3. Dissolved oxygen.
4. Bio-Chemical Oxygen Demand.
5. Chemical Oxygen Demand.
6. Electrical Conductivity.
7. Determination of Phosphates by spectrophotometer.
8. Determination of Nitrates by spectrophotometer.
9. Determination of heavy metals like Cr6+ or Zn or Ni or Cd.
10. Determination of total nitrogen by Kjeldal method.
11. Visit to domestic / Industrial wastewater treatment plant & its detailed reports.

12. Computer aided design of Sewage Treatment Plant (STP) OR Effluent Treatment Plant (ETP) of Sugar or Dairy Industry using suitable software (C programming or any other suitable software).

Note: - Term Work should include a detailed analysis of practical interpretation, significance and application of test results.

Text Books:

1. Environmental studies by Rajgopalan- Oxford University Press.
2. Waste Water Treatment & Disposal – Metcalf & Eddy - TMH publication.
3. Environmental Engg. - Peavy, Rowe - McGraw Hill Publication.
4. Waste Water Treatment – Rao & Dutta.

Reference Books:

5. Waste Water Engg. – B.C. Punmia & Ashok Jain - Arihant Publications.
6. Water Supply & Waste Water Engg.- B.S.N. Raju – TMH publication.
7. Sewage Disposal & Air Pollution Engg. – S. K. Garg – Khanna Publication.
8. Environmental Engg. – Davis - McGraw Hill Publication.
9. Manual on sewerage and sewage treatment – Public Health Dept., Govt. of India.
10. Standard Methods by APHA.

I.S. Codes:

I.S. 3025 (all parts).

e – Resources:

i) http://nptel.iitm.ac.in/courses-contents/IIT Kanpur and IIT Madras.

ii) http://cpcb.nic .in

iii) http://moef.nic .in

401 002 Transportation Engineering

Teaching scheme
Lectures: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme
In-Sem Exam: 30 Marks 1 Hr.
End-Sem Exam: 70 Marks 2.5 Hrs.
Term work: 50 Marks

Unit I **(6 Hrs.)**

Highway Development & Planning:

History, Development Plans, Classification of roads, Road Patterns, road development in India - Vision 2021 & Rural Road Development Vision 2025, Current road projects in India; highway alignment and highway project report preparation (Planning surveys & Master Plans based on saturation system).

Unit II: **(6 Hrs.)**

Geometric design of highways:

Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems, Highway drainage, Importance of highway drainage, subsurface and surface drainage systems.

Unit III **(6 Hrs.)**

Traffic engineering & control:

Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control devices (signs, signals, islands, road markings); Accident studies, types of road intersections; parking studies; highway lighting.

Unit IV **(6 Hrs.)**

Pavement materials:

Materials used in Highway Construction and related tests - Soil subgrade and CBR Test, Stone aggregates, bituminous binders, bituminous paving mixes, viscosity based gradation of bitumen, Modified Bitumen (Cutbacks, Emulsions, Crumbed Rubber Modified Bitumen – CRMB, Polymer Modified Bitumen-PMB, Foamed Bitumen), Marshall Stability Mix Design and Test (All 5 test parameters).

Unit V **(6 Hrs.)**

Pavement Design:

Introduction; flexible pavements – Computation of design traffic (Vehicle Damage Factor VDF, Lane distribution factor LDF, Traffic growth rate); stresses in flexible pavements; design guidelines for flexible pavements as per IRC 37-2012 (steps only); rigid pavements- components and functions; factors affecting design; stresses in rigid pavements (ESWL); design guidelines for concrete pavements as per IRC 58-2015 (steps only); joints in CC pavements, problems.

Unit VI **(6 Hrs.)**

A. Pavement Construction:

Construction process of GSB, WBM, WMM; Cemented base, Introduction to bituminous works such as prime coat, tack coat, seal coat, Built-up Spray Grout (BSG), Asphaltic Concrete (AC) or Bituminous Concrete (BC), Bituminous Macadam (BM), Dense Bituminous Macadam (DBM) and premix carpet, Dry lean Concrete (DLC), Pavement Quality Concrete (PQC).

B. Modern Trends in Highway Materials, Construction & Maintenance:

Mastic Asphalt, Cold Mix Asphalt Technology, Warm Mix Asphalt Technology, Recycled/Reclaimed Asphalt Pavement (RAP) (Manual Series - 2), Concept of Super pave Mix Design (Super pave Series 2), Non-Destructive Evaluation of Pavements (Falling Weight Deflectometer FWD).

Term work:

Term work shall consist of the following:

A. Practicals:

I. Tests on Aggregate (Any Five) :

1. Aggregate Impact Value Test
2. Aggregate Crushing Strength Test
3. Los Angeles Abrasion Test
4. Shape Test (Flakiness Index and Elongation Index)
5. Specific Gravity and Water Absorption Test by basket method
6. Stripping Value Test
7. Soundness Test

II. Tests on Bitumen (Any Five):

1. Penetration Test
2. Ductility Test
3. Viscosity Test (Tar Viscometer)
4. Softening Point Test
5. Flash Point & Fire Point Test
6. Specific Gravity Test
7. Bitumen Extraction Test

III. Tests on Aggregate Bitumen Combined:

1. Marshall Stability Test

IV. Tests on Soil Subgrade:

1. California Bearing Ratio Test (CBR Test)

B. Technical visits to:

1) Road Construction and/or RAP Site
2) Hot mix Plant with detailed report

Text Books:

1. Highway engineering – S.K. Khanna, C.E.G. Justo & A. Veeraragavan, Nem Chand and Brothers, Roorkee
2. Principles of Highway Engineering and Traffic Analysis (4^{th} edition) F. L. Mannering, Scott S. Washburn, Wiley India
3. Principles and practices of Highway engineering –Dr. L.R. Kadiyali, Khanna Publishers Delhi.

Reference Books:

1. A Course in Highway Engineering – S.P. Bindra, Dhanpat Rai and Sons, Delhi.
2. Principles of Transportation Engineering – G.V. Rao Tata MacGraw Hill Publication
3. Highway Engineering – Rangawala, Charotar publishing House, Anand 388001 (Gujrat)
4. Principles of Transportation Engineering – Partha Chakraborty, Animesh Das, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Highway and Bridge Engineering – B.L. Gupta, Amit Gupta Standard publishers Distributors, Delhi.

Other References:

1. National Cooperative Highway Research Program (NCHRP)
2. Federal Highway Authority (FHWA)

Codes:

1. I.S. 1201 TO 1220-1978, IS 73, IS 2386 PART I toV
2. I.R.C. 58- 2015, IRC 37-2012
3. Specifications for Road and Bridge works (MORTH) 5th Revision, New Delhi.

e – Resources:

1. www.nptel.iitm.ac.in/courses/iitkanpur
2. www.cdeep.iitb.ac.in/nptel
3. www.fhwa.dot

401 003 Structural Design and Drawing III

Teaching Scheme:
Lectures: 4 Hrs / week
Practical: 2 Hrs/week

Examination Scheme:
In Sem: 30 and End Sem : 70 Marks
Oral: 50 Marks
Duration: In-Sem: 1.5 Hrs.
End-Sem: 3 Hrs.

Unit 1 **(8 Hrs.)**

Prestressed concrete – Analysis:

Introduction, Basic concepts, materials, various Pre-tensioning and Post-tensioning systems, concept of losses, Stress calculations, and concept of cable profile.

Unit 2 **(8 Hrs.)**

Prestressed concrete – Design:

Design of post tensioned prestressed concrete simply supported rectangular and flanged sections for flexure and shear including end block.

Design of one way and two way post tensioned slabs (Single panel only).

Unit 3 **(8 Hrs.)**

Design of Flat slab:

Introduction to flat slab, Design of prestressed two way flat slab by direct design method.

Unit 4 **(8 Hrs.)**

Earth retaining structures:

Introduction, Functions and types of retaining walls, Analysis and design of RCC cantilever type of retaining wall for various types of backfill conditions.

Unit 5 **(8 Hrs.)**

Liquid retaining structures:

Introduction, types, function, codal provisions, methods of analysis, Design of circular, square, and rectangular water tanks resting on ground by working stress method, Introduction to limit state design of water tanks.

Unit 6 **(8 Hrs.)**

Introduction to vibration and earthquake analysis:

Introduction to single and multi-degree of freedom systems: free, forced, un-damped and damped vibration, Estimation of earthquake forces by seismic coefficient method, Estimation of combined effect of lateral forces and vertical loading on G+2 storied frames.

Note: Design based on above unit shall conform to latest versions of IS 456, IS 875, IS 1343, IS 3370, IS 1893, IS 13920.

Term Work:

Term work shall be based on the above syllabus. It consists of

1) Assignment on calculation of losses in prestress.
2) Assignment on stress calculation in prestressed structures.
3) Design and detailing of design of prestressed girder.
4) Design and detailing of prestressed flat slab by direct design method.
5) Design and detailing of retaining wall for various loading conditions.
6) Design and detailing of ground resting water tank.
7) Report on analysis and design of any one of the structures listed in the syllabus using software or computer program.
8) Two site visit reports, one each on RCC and Prestressed concrete structure.

Note:

(a) There should be separate design problem statement for a group of students not exceeding *four* in numbers.
(b) Minimum four full imperial sheets based on two projects on design of RCC and two projects on design of prestressed concrete structural elements.

Text Books:

1. Limit state theory and design of reinforced - Dr. V. L. Shah and Dr S. R. Karve - Structures Publications, Pune.
2. Fundamentals of Reinforced Concrete- N.C. Sinha, S.K. Roy – S. Chand & Co. Ltd
3. Advanced design of structures- Krishnaraju - Mc Graw Hill.
4. Design of Prestressed concrete structures- T. Y. Lin.
5. Prestressed Concrete- N. Krishna Raju – Tata Mc Graw Hill Publication Co.
6. Earthquake resistant design of structures- Agarwal, Shrikhande, PHI learning.

Reference Books:

7. Comprehensive RCC Design - Punmia, Jain & Jain - Laxmi Publications.
8. Design of design of reinforced Concrete structures- M. L. Gambhir –PHI.
9. Reinforced Concrete, Vol I- Dr.H J. Shah Charotar Publishing House
10. Prestressed Concrete – A Fundamental Approach- Edward Nawy – PHI..
11. Reinforced concrete design- Pillai and Menon TMH.
12. Elementary Structural Dynamics-Selvam, Dhanpatrai Publications.

I.S. Codes

1. IS: 456: Indian Standard code of practice for plain and reinforced concrete, BIS, New Delhi.
2. IS: 1343: Indian Standard code of practice for Prestressed concrete, BIS, New Delhi.
3. IS: 1893: Indian Standard Code of practice for criteria for Earthquake resistant design of structures, BIS, New Delhi.
4. IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, BIS, New Delhi.

401 004 Elective I: (1) Structural Design of Bridges

Teaching Scheme:
Lecture: 3 Hrs/week.
Practical:- 2 Hrs/week

Examination Scheme:
In-sem. Exam.: 30 Marks (1 Hr.)
End Sem. Exam.: 70 Marks (2.5 Hrs.)
Term work: 50 Marks.

Unit 1 **(6 Hrs.)**

Introduction to RC highway bridges and steel railway bridges: Types of bridges, classification, IRC codal provisions for RC highway bridges, IRS codal provisions for railway steel bridges, loading standards.

Unit 2 **(6 Hrs.)**

RC highway bridges: Slab culvert and T-beam deck slab bridges – Design of slab culvert, Deck slab: Structural configuration, Piegaud's method, analysis and design of deck slab.

Unit 3 **(6 Hrs.)**

RC highway bridges: T-beam deck slab bridges – Post tensioned girders: Load distribution on longitudinal and cross girders, methods of analysis, analysis and design of longitudinal and cross girders.

Unit 4 **(6 Hrs.)**

Railway steel bridges – Truss bridges: Structural configurations, loads and load combinations, analysis and design of truss elements, longitudinal and cross-girders, bracing systems.

Unit 5 **(6 Hrs.)**

Bearings: Function of bearings, types of bearings, design of steel bearings and elastomeric bearings.

Unit 6 **(6 Hrs.)**

Sub-structure: Function, loads, analysis and design of RC abutments and piers, design of well foundation.

Note: The designs should conform to the latest codal provisions.

Term Work:

a) One project on RC highway bridges which shall include - the design of deck slab, longitudinal girder, cross-girder, bearings and abutment and pier.

The detailing shall be shown in at least three full imperial sheets.

b) One project on railway steel bridges which shall include – the design of truss elements, longitudinal girder, cross-girder, and bearings.

The detailing shall be shown in at least two full imperial sheets.

c) The term work can be prepared in a group of not more than four students in a group.

d) Report of at least two site visits covering the contents of the syllabus.

e) The projects can be done using any drafting software.

Reference Books:

1. Design of Bridges, N. Krishna Raju, Oxford and IBH Publishing Company Pvt. Ltd.
2. Design of Bridge Structures, M.A. Jayaram Prentice-Hall Of India Pvt. Limited. Prestressed Concrete, N. Krishna Raju, Tata-McGraw Hill.
3. Design of Steel Structures, Ramachandra, Standard Publications New-Delhi.

401 004 Elective I (2) - Systems Approach in Civil Engineering

Teaching scheme:
Lectures: 3 Hrs/week
Practical: 2 Hrs/week

Examination scheme:
In semester exam: 30 marks---1 Hr.
End semester exam: 70 marks—2.5 Hrs.
Term Work: 50 marks.

Unit 1: Introduction of systems approach (6 Hrs)

(A) Introduction to System approach, Operations Research and Optimization Techniques, Applications of systems approach in Civil Engineering.

(B) Introduction to Linear and Non linear programming methods (with reference to objective function, constraints), Graphical solutions to LP problems.

(C) Local & Global optima, unimodal function, convex and concave function.

Unit 2: Stochastic Programming (6 Hrs)

(A) Sequencing– n jobs through 2, 3 and M machines.

(B) Queuing Theory : elements of Queuing system and it's operating characteristics, waiting time and ideal time costs, Kendall's notation, classification of Queuing models, single channel Queuing theory : Model I (Single channel Poisson Arrival with exponential services times, Infinite population (M/M/1) : (FCFS/ /).

(C) Simulation : Monte Carlo Simulation.

Unit3: Linear programming (A) (6 Hrs)

(A) The Transportation Model and its variants.

(B) Assignment Model, and its variants.

Unit 4: Linear programming (B) (6 Hrs)

(A) Formulation of Linear optimization models for Civil engineering applications. The simplex method.

(B) Method of Big M, Two phase method, duality.

Unit 5: Nonlinear programming (6 Hrs)

(A) Single variable unconstrained optimization: Sequential Search Techniques-Dichotomous, Fibonacci, Golden section.

(B) Multivariable optimization without constraints-The gradient vector and Hessian Matrix, Gradient techniques, steepest ascent/decent technique, Newton's Method.

(C) Multivariable optimization with equality constraints - Lagrange Multiplier Technique.

Unit 6: Dynamic programming, Games Theory & Replacement Model (6 Hrs)

(A) Multi stage decision processes, Principle of optimality, recursive equation, Applications of D. P.

(B) Games Theory – 2 persons games theory, various definitions, application of games theory to construction Management.

(C) Replacement of items whose maintenance and repair cost increase with time, ignoring time value of money.

Term Work :

1. One exercise/assignment on each unit. Out of these any one exercise/assignment to be solved using Computer.
2. One exercise on formulation of a problem applicable to any field of Civil Engineering, requiring use of LP/ NLP/ DP. Formulation of objective function and constraints (No solution).

Text Books :

1. Operations Research by Premkumar Gupta and D.S.Hira, S. Chand Publications (2014).
2. Engineering Optimization: Methods and Application-- A. Ravindran, K. M. Ragsdell— Wiley India.
3. Engineering Optimization by S. S. Rao.
4. Operations Research by Hamdy A. Taha.
5. Quantitative Techniques in Management by N.D. Vohra (Mc Graw Hill) .
6. Operations Research by Pannerselvam, PHI publications.

Reference Books :

1. Topics in Management Science by Robert E. Markland(Wiley Publication).
2. An Approach to Teaching Civil Engineering System by Paul J. Ossenbruggen.
3. A System Approach to Civil Engineering Planning & Design by Thomas K. Jewell (Harper Row Publishers).

e - Resources

1. Mathematical Model for Optimization (MMO Software).
2. nptel.iitm.ac.in/courses/webcourse-contents/IISc-Bang/OPTIMISATION METHODS/New-index1.html.

401004 Elective I (3) - Advanced Concrete Technology

Teaching scheme	**Examination scheme**
Lectures: 3 Hrs/week	**In semester exam: 30 Marks-1 Hr.**
Practical: 2 Hrs/week	**End semester exam: 70 Marks—2.5 Hrs.**
	Term Work: 50 Marks

Unit I **(6 Hrs.)**

Cement and its types: general, hydration of cement, alkali aggregate reaction. Grading curves of aggregates, Manufactured sand as fine aggregate, copper slag as fine aggregate.

Concrete: properties of concrete, w/b ratio, gel space ratio, Problems on maturity concept, aggregate cement bond strength, Green concrete, Guidelines for Quality control & Quality assurance of concrete, Effect of admixtures.

Unit II **(6 Hrs.)**

Structural Light weight concrete, ultra light weight concrete, vacuum concrete, mass concrete, waste material based concrete, sulphur concrete and sulphur infiltrated concrete, Jet cement concrete (ultra rapid hardening), gap graded concrete, high strength concrete, high performance concrete ,Self curing concrete, Pervious concrete, Geo polymer concrete .

Unit III **(6 Hrs.)**

Design of high strength concrete mixes, design of light weight aggregate concrete mixes, design of fly ash cement concrete mixes, design of high density concrete mixes, Design of pump able concrete mixes, Design of self-compacting concrete.

Advanced non-destructive testing methods: ground penetration radar, probe penetration, break off maturity method, stress wave propagation method, electrical/magnetic methods, nuclear methods and infrared thermographs**.**

Unit IV **(6 Hrs.)**

Historical development of fibre reinforced concrete, properties of metallic fibre, polymeric fibres, carbon fibres, glass fibres, Basalt fibres and naturally occurring fibres. Interaction between fibres and matrix (uncracked and cracked matrix), basic concepts and mechanical properties: tension and bending.

Unit V **(6 Hrs.)**

Properties of hardened frc, behavior under compression, tension and flexure of steel fibres and polymeric fibres, GFRC, SFRC, SIFCON,SIMCON -development, constituent materials, casting, quality control tests and physical properties.

Unit VI **(6 Hrs.)**

Ferrocement: Properties & specifications of ferrocement materials ,analysis and design of prefabricated concrete structural elements,manufacturing process of industrial concrete elements, precast construction, erection and assembly techniques.

Termwork / Labwork :

The Termwork / Labwork will be based on completion of assignments / practicals / reports of site visits, confined to the course in that semester.

1. Write a review on any recent research article from standard peer-reviewed journal.
2. Report on at least one patent (national/international)– on any topic related to concrete technology.
3. Concrete mix design and production in lab of any one – Self compacting concrete, Fiber reinforced concrete, light-weight concrete, high strength or ultra-high strength concrete . Comparison with traditional concrete mix is to be clearly stated in the report. 4. Cost analysis (material, labour, equipment, others) of any type of concrete for lab, in-situ and RMC production.
4. Perform any two Fresh (workability tests – Slump Flow Test, T-50, J-Ring, Visual Stability Index, Column Segregation, L-Box, U-box) and Hardened (Compressive, tensile, flexural) properties tests on any high performance concrete.
5. Any one experiment on any one of the topics – NDTs; Microscopic examination of cement/concrete; Performance study of any one admixture (Mineral/Chemical) in concrete.
6. Visit reports on minimum two site visits - exploring the field and practical aspects of concrete technology.

Note:

Term Work should include a detailed analysis of practical interpretation, significance and application of test results including above contents and site visit report in form of journal.

Text books:

1. Concrete Technology --M.S. Shetty, S. Chand Publications.
2. Concrete Technology -- A R Santhakumar, Oxford University Press.
3. Concrete technology -- M. L. Gambhir, Tata Mcgraw Hill Publications.
4. Fiber Reinforced Cement Composite- P.N.Balguru & P.N.Shah.
5. Concrete: Microstructure, Properties and Materials-- P. Kumar Mehta and P. S. M. Monteiro-- Tata Mc-Graw Hill Education Pvt. Ltd.

Reference Books:

1. Handbook on Advanced concrete Technology Edited by N V Nayak,A .K.Jain, Narosa Publishing House .
2. Design of concrete mixes by Raju N Krishna, CBS Publisher.
3. Properties of concrete by A. M. Neville, Longman Publishers.
4. Concrete Technology by R.S. Varshney, Oxford and IBH.
5. Concrete technology by A M. Neville, J.J. Brooks, Pearson.
6. Ferrocement Construction Mannual-Dr. D.B.Divekar-1030, Shivaji Nagar,Model Colony, Pune.
7. Concrete Mix Design-A.P.Remideos--Himalaya Publishing House (ISBN-978-81-8318-996-5
8. Concrete, by P. Kumar Metha, Gujrat Ambuja.
9. Learning from failures ---- R.N.Raikar.
10. Structural Diagnosis ---- R. N. Raikar.
11. Concrete Mix Design---Prof. Gajanan Sabnis.

General Reading suggested:

1) Codes : i) IS 456 ii) IS 383 iii) IS 10262-2009 iv) IS 9103.

2) Ambuja cement booklets on concrete Vol .1 to 158.

3) ACC booklets on concrete.

401 004 Elective I (4)- Architecture and Town Planning

Teaching scheme:	**Examination scheme:**
Lectures: 3 Hours/week	**In semester exam: 30 marks-1 Hr.**
Practical: 2 Hrs/week	**End semester exam: 70 marks-2.5 Hrs.**
	Term Work: 50 marks

Unit I **(6 Hrs.)**

- Principles and elements of Architectural Composition.
- Qualities of Architecture: user friendly, contextual, ecofriendly, utility of spaces, future growth etc.
- Role of "Urban Planner and Architect" in planning and designing in relation with spatial organization, utility, demand of the area and supply.

Unit II: **(6 Hrs.)**

- Landscaping: importance , objectives, principles, elements, material (soft and hard).
- Urban renewal for quality of life and livability.
- Importance of sustainable architecture with case study.

Unit III: **(6 Hrs.)**

- Goals and Objectives of planning; components of planning; benefits of planning.
- Levels of planning: Regional plan, Development Plan, Town Planning Scheme.
- Neighborhood plan; Types of Development plans: Master Plan, City Development Plan, Structure Plan.

Unit IV: **(6 Hrs.)**

- Various types of civic surveys for DP: demographic, housing, land use, Water Supply & sanitation, etc.
- Planning agencies for various levels of planning. Their organization and purpose (CIDCO-MHADA-MIDC, MMRDA/ PMRDA etc).
- Traffic transportation systems: urban road, hierarchy, traffic management, Intelligent Transport Systems.

Unit V: **(6 Hrs.)**

• Legislative mechanism for preparation of DP: MRTP Act 1966.

• UDPFI guidelines (for land use, infrastructure etc.), SEZ, CRZ, Smart City Guidelines.

Unit VI : **(6 Hrs.)**

• Special townships, Land Acquisition Rehabilitation and Resettlement Act 2013.

• Application of GIS, GPS, remote sensing in planning.

Term Work: - 50 Marks

Sr. no. 1 and 2 are compulsory and any four from remaining.

1. Study and analysis of Development Plan with respect to land use, services, infrastructure, street furniture, housing etc. (group work).
2. Neighborhood- planning (group work).
3. Report on contribution of Engineers, Planners and Architects in post-independence India (individual work).
4. Report on any existing new towns and planned towns like new Mumbai, Gandhinagar, PCNTDA etc.(infrastructure, disaster management etc), (individual work).
5. Study of salient features of urban renewal schemes (group work).
6. Study of any existing town planning scheme (group work).
7. Smart City approaches (individual work).
8. Study of Special Townships: (site visit) (group work).
9. Study of urban housing and housing change (group work).

Text Books:

1. Town Planning By G K Hiraskar --Town Planning by S Rangwala.
2. Building Drawing and Built Environment- 5^{th} Edition – Shah, Kale, Patki--Planning Legislation by Koperdekar and Diwan.
3. G. K. Bandopadhyaya, “Text Book of Town Planning”.
4. Climate Responsive Architecture – Arvind Krishnan.
5. Introduction to Landscape Architecture by Michael Laurie.

Reference Books:

- MRTP Act 1966.
- Manual Of Tropical Housing And Building By Koenigsbeger.

- Sustainable Building Design Manual.
- UDPFI Guidelines.
- “The Urban Pattern: City planning and design” by Gallion and Eisner.
- Design of cities by Edmond bacon.
- LARR Act 2013.
- MoUD By GoI.
- Web sites of NRSA, CIDCO, MHADA, MIDC, MMRDA, PMRDA.

401004 Elective-I (5) Advanced Engineering Geology with Rock Mechanics

Teaching Scheme:
Lecture: 3 Hrs/week
Practical: 2 Hrs/week

Exam. Scheme:
In Sem: 30 Marks (1 Hr.)
End Sem: 70 Marks (2.5 Hrs.)
Termwork: 50 Marks

Unit I: **(6 Hrs.)**

Indian Geology, Seismic Zones and Geological Studies in Engineering Projects.

Geological Map of India with special reference to Maharashtra. Distribution and Geological characters of Major rock formations of India. Engineering characters of major rock formations of India. Engineering characters of major rock formations of India. Engineering characters of major rock formations of India. Engineering characters of major rock formations of India.

The study of Plate Tectonics and highlights of Seismic Zones of India. Importance of geological studies in engineering investigations.

Unit II **(6 Hrs.)**

Geohydrological characters of rock formations and Geological process of Soil formations

Geohydrological characters of major rock formations of India:

Geohydrological characters and factors controlling various characters of rocks. Introduction to morphometric analysis. Various water conservation techniques, effect of over exploitation of tube wells, bore wells and dug wells. Artificial recharge, rainwater harvesting, watershed development and necessity of geological studies. Relevant case studies highlighting success and failure of these techniques.

Geological Process of Soil formations:

Effect of climate on formation of soil. Soil profile of different states in India.

Rock weathering conditions favorable for decomposition, disintegration, residual and transported soils.

UNIT III **(5 Hrs.)**

Resource Engineering, Role of Geology in planning and development.

Resource Engineering:

Utility of various rock formations as construction material. Illustrative case studies.

Geological Hazards and mitigation.

Role of Geology in planning and development:

Influence of geological factors upon urban development & planning. Reclamation of abandoned grounds and mining regions, illustrative examples.

UNIT IV: (6 Hrs.)

Rock Mechanics and Geophysical techniques.

Rock Mechanics:

General principles of rock mechanics. Dependence of physical and mechanical properties of rocks on geological characters.

Analyzing and evaluating of core recovery, R.Q.D. and Joint Frequency Index.

Various Methods of Geomechanical classifications of rocks such as Terzahagi, U.S.B.M, R.M.R., R.S.R., Q- system, Deer and Miller, Bieniawaski's geomechanical classification etc.

Geophysical techniques :

Electrical Resistivity method and Seismic method of exploration. Evaluation and analyzing the data produced through electrical resistivity for the determination of thickness of overburden, locating ground water potential zones which leads for strengthening the major civil projects.

UNIT V (7 Hrs.)

Subsurface Geological Explorations for various projects; Foundation Treatments, Tail Channel Erosion.

Subsurface Explorations for Dams, Reservoir, Percolation Tanks:

The strength and water tightness of rocks found at the dam, reservoir and percolation tank site.

Case studies illustrating the success and failure of major projects owing to negligence of geological studies. Earthquakes occurring in the areas of some dams and RIS theories.

Geological Foundation Treatments for various Civil Engineering Projects:

Foundation investigation during construction of projects for assessing various geological defects in rocks and suggesting appropriate remedial measures by various methods of grouting.

Erosion of Tail Channels:

Geological reasons for selection of site for spillway, causes of erosion of tail channel. Relevant Case studies.

Unit VI: **(6 Hrs.)**

Geological exploration for Tunnels and Bridges

Geological exploration for Tunnels:

Variations in methodology of investigation for different types of tunnels for different purposes, location, spacing, angles & depths of drill holes suitable for different types of tunnels.

Difficulties introduced in various geological formation and their unfavorable field characters. Standup time of rock masses and limitations of it.

Dependence of protective measures such as guniting, rock bolting, shotcreting, steel fiber shotcreting, permanent steel supports, lagging concreting & grouting above permanent steel supports on geological conditions. Illustrative case studies.

Bridges Investigation for bridge foundation, difference in objectives of investigation of bridge foundation. Bridge foundation based on nature & structure of rock. Foundation settlements. Case studies.

Practical Work / Term Work

i. Study of Geological map and seismic zone map of India **(2 Practicals)**

ii. Study of Morphometric Analysis of river, (topsheet will be made available by the college) **(1 Practical)**

iii. Study of Soil Profile, weathering index and clay geology. **(1 Practical)**

iv. Use of electrical resistivity method for determining depth of bedrock. **(1 Practical)**

v. Engineering Classification of rocks and Computation of RQD & Joint Frequency Index **(1 Practical)**

vi. Interpretation of drill hole data. Logging of drill cover, preparation of Litho logs & interpretation of drill data. Preparing geological cross sections from drill hole data & using them for designing of civil engineering structures representing following case studies.

1. Dipping sedimentary formation.
2. Faulted region.
3. Folded region.
4. Locating spillway.
5. Tunnels in Tectonic areas.
6. Tunnels and open cuts in non-tectonic areas. **(6 Practicals)**

vii. A compulsory guided tour to study geological aspects of an engineering projects & writing a report based on studies carried out during visits to civil engineering projects.

Note:

Field visits will be made to different places around study area and one study tour to important geological places.

The practical journal will be examined as term work**.**

REFERENCE BOOKS AND TEXT BOOKS:

1. Jaeger J. C., Cook N. & Zimmerman R. – Fundamentals of Rock Mechanics, Blackwell Scientific Publications.
2. Goodman R. E. – Introduction to Rock Mechanics, John Wiley & Sons.
3. Bieniawski Z. T. - Engineering Classification of jointed Rock Masses.
4. M. B. Dobbrin - Introduction to Geophysical Prospecting, McGraw Hill Inc., USA.
5. B. P. Verma - Introduction to Rock Mechanics, Khanna Pub New Delhi.
6. Keller E A - Environmental Geology, Prentice – Hall Publication.
7. Subinoy Gangopadhyay - Engineering Geology, Oxford University Press.
8. Vasudev Kanithi – Engineering Geology, Universities Press.
9. Dr. J. B. Auden Commemorative Volume – Indian Soc. Of Engineering Geology, Culcutta.
10. Seminar on Engineering and Geological Problems in Tunneling (Part 1 & 2) – Indian Society of Engineering Geology, New Delhi.

Handbooks:

a. Gupte R. B. (1980) – P. W. D. Handbook Chapter –6, Part-II 'Engineering Geology Government of Maharashtra.

b. Tunneling India '94, "Central Board of Irrigation and Power", New Delhi.

c. Manual on Rock Mechanics, Central Board of Irrigation and Power, New Delhi, 1988.

d. Handbook of Geology in Civil engineering, Robert Fergussion, Legget, Mc- Graw hill.

I. S. Codes

a. IRC code of practice for Road Tunnels. IRC-78-2000; IS-12070; IS-1336 Part I and II.

b. I. S. 4453-1967 Code of practice for Exploration, pits, trenches, drifts & shaft.

c. I. S. 6926-1973 Code of practice for diamond drilling for site investigation river valley project.

d. I. S. 4078-1967 Code of practice for Logging and Storage of Drilling Core.

e. I. S. 5313-1969 Guide for core drilling observation.

e- Resources:

1. www.ebd.co.in/undergraduate/eng
2. www.library.iisc.ernet.in
3. www.iitb.ac.in
4. www.nptel.iitm.ac.in
5. Free online course-swayam-https//swayam.gov.in
6. Open source course management – https//moodle.org

401 005 Elective-II (1) Matrix Methods of Structural Analysis

Teaching scheme:
Lectures: 3 Hrs/week

Examination scheme:
In semester exam: 30 marks (1 Hr.)
End semester exam: 70 marks (2.5 Hrs.)

Unit I: Computational Techniques (6 Hrs)

Review of matrix algebra, computer oriented numerical methods-Gauss elimination, Gauss Jordon and Gauss Seidel. Computer algorithm and flowcharts of above methods.

Unit II: Flexibility matrix method for beams and frame (6 Hrs)

Degree of static indeterminacy, flexibility, selection of redundant, flexibility matrix, analysis of indeterminate continuous beams and simple portal frames involving not more than three unknowns.

Unit III: Stiffness matrix method for bars and trusses (6 Hrs)

a) Degree of kinematic indeterminacy (degrees of freedom), local and global coordinate systems, stiffness matrices of a axially loaded bar members, global stiffness matrix, analysis of determinate/indeterminate bars involving not more than three unknowns using member approach.

b) Stiffness matrices of a truss member with four DOF, transformation matrix, global stiffness matrix, analysis of determinate/indeterminate trusses involving not more than three unknowns using member approach.

Unit IV: Stiffness matrix method for beams (6 Hrs)

a) Structure approach: Degree of kinematic indeterminacy, problems involving not more than three unknowns.

b) Member approach: Derivation of stiffness matrix for beam member, Global stiffness matrix, problems involving not more than three unknowns.

Unit V: Stiffness matrix method for frames (6 Hrs)

a) Structure approach: Degree of kinematic indeterminacy, problems involving not more than three unknowns.

b) Member approach: Derivation of stiffness matrix for plane and space frame member, transformation matrix, global stiffness matrix, problems involving not more than three unknowns.

Unit VI: Stiffness matrix method for grid structures (6 Hrs)

a) Structure approach: Degree of kinematic indeterminacy, problems involving not more than three unknowns.

b) Member approach: Derivation of stiffness matrix for grid member, transformation matrix, global stiffness matrix, problems involving not more than three unknowns.

Reference Books:

[1] Matrix Methods of Structural Analysis- Wang, C. K., International Textbook Co., 1970.

[2] Matrix Analysis of Framed Structures – Gere & Weaver- CBS Publications, Delhi.

[3] Matrix & Finite Element analysis of structures – A.H. Shaikh and Madhujit Mukhopadhyay.

[4] Numerical Methods for Engineering – S.C. Chapra& R.P. Canale Tata McGraw Hill Publication.

[5] Structural Analysis – A Matrix Approach – Pandit & Gupta - Tata McGraw Hill Publication.

[6] Matrix Methods of Structural Analysis – Meghre & Deshmukh- Charotar Publishing House, Anand.

401005 Elective-II (2) Integrated Water Resources Planning & Management

Teaching Scheme: Lectures: 3 Hrs / week

Examination Scheme:
Paper In-sem. 30 Marks (1 hr),
Paper End-sem : 70 Marks (2.5 hr)

Unit1: (6 Hrs)

a) Introduction :World water resources, water resources in India, water as finite resource, variability of water in time & space, history of water resources development, water infrastructure-problems and perspectives, present institutional framework for water management.

b) Water laws: Constitutional provisions, National Water Policy, riparian rights / ground water owner ship, prior appropriation, permit systems, acquisition and use of rights, scope for privatization. EPA 1986, MWRRA act.

Unit2: Economics & Paradigm shift in water management (6 Hrs)

a) Economics of water :Water as economic good, intrinsic value, principles of water pricing & water allocation, capital cost, opportunity cost, internal rate of return, benefit cost analysis, principles of planning and financing of water resources project : Discussion on any two case studies.

b) Paradigm shift in water management:

Global and national perspectives of water crisis, water scarcity, water availability and requirements for human and nature, concepts of ‘blue water’, ‘Green water’, and ‘virtual water’, and their roles in water management. Sustainability principles for water management, framework for planning a sustainable water future.

Unit 3: Basin scale flogy (6 Hrs)

a) Estimation of surface water, estimation of ground water draft/recharge import/export of water (inter basin water transfer, interlinking of national river), recycling and reuse and storage, control of water logging, salinity, & siltation of storages.

b) Flood & Drought management: causes of floods, structural and non-structural measures, mitigation plan, flood damage assessment, use of geoinformatics for flood management. Types of droughts, severity index, drought forecasting, damage assessment, mitigation plan, use of geoinformatics for drought management.

Unit 4: Water demand and supply based management **(6 Hrs)**

a) Consumptive & non consumptive demands, irrigation demand estimation, water utilization, irrigation efficiency, water management in irrigation sector.

b) Demand estimation in hydro/thermal/nuclear power sector, estimation & forecasting of water demands of domestic & industrial sector, navigation and recreational water demands.

Unit 5: Environmental and social aspects **(6 Hrs)**

a) Environmental management: protection of vital ecosystem, water requirements for environmental management, aquaculture, minimum flows, environmental flow, water quality management for various uses.

b) Social impact of water resources development: direct/ indirect benefits, employment generation, industrial growth, agro-industry, enhanced living standards, education & health, co-operative movement, management of rehabilitation & resettlement, interstate dispute of water sharing and tribunals, sectorial conflicts.

Unit6: Basin planning &Watershed management **(6 Hrs)**

a) Perspective plan for basin development & management, Decision support system for Integrated Water Resources Management (IWRM), use of data driven techniques like Artificial Neural Networks, Genetic programming, Model Tree in water resources planning, development & management.

b) Watershed Management:

Watershed definition, classification of watersheds, integrated approach for watershed management, role of RS & GIS in watershed management, soil and water conservation-necessity- soil erosion-causes- effects-remedial measures, contour bunding-strip cropping-bench terracing-check dams, farm ponds, percolation tank.

Text Books:

1) Water Resources Systems Engg, D. P. Loucks, Prentice Hall
2) Water Resources Systems Planning and Management, Chaturvedi, M.C. Tata McGraw Hill
3) Economics of Water Resources Planning, James L.D and Lee R.R, McGraw Hill
4) Water resources hand book; Larry W. Mays, McGraw International Edition
5) Design of Water Resources Systems, Arthur Mass, MacMillan 1962
6) Water resource system, Pramod .R. Bhave - Narosa Publication

Reference Books:

1. Economics of Water Recourses Planning, L. D. James & R.R.Leo, McGraw Hills, NY 1971.
2. Water Resources Systems Engineering, W. A. Hill & J. A. Dracup.
3. Water shed Management – B.M. Tideman
4. Watershed management –J. V. S. MURTY, new Age International Publisher.
5. Integrated Watershed Management Perspectives and Problems - Beheim, E., Rajwar, G.S., Haigh, M., Krecek, J. (Eds.) , Springer Publication.
6. Managing Water in River Basins: Hydrology, Economics and Institutions -- M. Dinesh
7. Kumar, Publisher: Oxford Universit Press
8. Water Resources Design Planning Engg. and Economic; Edward Kuiper, Butterworth & Co.
9. ANN in Hydrology; Govinda Raju & Ramachandra Rao; PHI
10. Integrated Water Resources Management in Practice: Better Water Management for Development - R. L. Lenton, Mike Muller , Publisher Earthscan.
11. Sustainability of Integrated Water Resources Management - Editors**:** Setegn, Shimelis Gebriye, Donoso**,** Maria Concepcion (Eds.) Publisher Springer International Publishing .
12. Integrated Water Resources Management in the 21st Century: Revisiting the paradigm -Pedro Martinez-Santos, Maite M. Aldaya, M. Ramón Llamas, Publisher CRC Press, Taylor & Francis Group.
13. Key Concepts in Water Resource Management: A Review and Critical Evaluation - Jonathan Lautze, publisher Routledge.
14. Water Management – Jasapal Singh, M.S.Achrya, Arun Sharma – Himanshu Publication.

e – Resources:

1. nptel.iitm.ac.in/courses /webcourse-contents / IISc-Bang/water resource management.

401 005 Elective II (3) TQM and MIS in Civil Engineering

Teaching scheme:
Lectures: 3 Hrs/week

Examination scheme:
In semester exam: 30 marks---1 Hr.
End semester exam: 70 marks—2.5 Hrs.

Unit I: Quality in Construction (6 Hrs)

a) Quality – Various definitions and interpretation. Importance of quality on a project in the context of global challenges, Factors affecting quality of construction, Reasons for poor quality & measures to overcome, Contribution of various Quality Gurus(Juran, Deming, Crossby, Ishikawa).
b) Evolution of TQM- QC, TQC, QA, QMS, TQM.

Unit II: TQM & Six Sigma (6 Hrs)

a) TQM – Necessity, advantages , 7QC tools, Quality Function Deployment(QFD).
b) Six sigma – Importance, levels.
c) Defects & it's classification in construction. Measures to prevent and rectify defects.

Unit III: ISO & Quality Manual (6 Hrs)

a) Study of ISO 9001 principles.
b) Quality manual – Importance, contents, documentation. Importance of check-lists in achieving quality. Typical checklist for concreting activity, formwork activity, steel reinforcement activity.
c) Corrective and Preventive actions, Conformity and NC reports.

Unit IV: Management Control & Certifications (6 Hrs)

a) Benchmarking in TQM, Kaizen in TQM.
b) Quality Circle.
c) Categories of cost of Quality.
d) CONQAS, CIDC-CQRA certifications.

Unit V: Techniques in TQM Implementation and awards (6 Hrs)

a) 5 'S' techniques.
b) Kaizen.
c) Failure Mode Effect Analysis (FMEA).

d) Zero Defects.

e) National & International quality awards- Rajeev Gandhi Award, Jamuna lal Bajaj Award, Golden Peacock Award, Deming Prize, Malcolm Baldrize award.

Unit VI: MIS **(6 Hrs)**

a) Introduction to Management Information systems (MIS) Overview, Definition.

b) MIS and decision support systems, Information resources, Management subsystems of MIS, MIS based on management activity whether for operational control, management control, strategic control.

c) Study of an MIS for a construction organization associated with building works.

Text Books:

1. Total Quality Management-- Dr. Gunmala Suri and Dr. Puja Chhabra Sharma—Biztantra.
2. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ. Company.
3. Total Quality Management - Dr. S.Rajaram and Dr. M. Sivakumar—Biztantra.
4. Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.

Reference Books:

1. Juran's Quality Handbook – Juran Publication. Importance of quality on a project in the context of global challenges. Importance of quality on a project in the context of global challenges.
2. Management –Principal, process and practices by Bhat – Oxford University Press.
3. Financial management by Shrivastava- Oxford University Press.
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ. Co.
5. Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.

E- Sources:

www.nptel.ac.in , www.mobile.enterpriseappstoday.com

401 005 Elective II (4) Earthquake Engineering

Teaching scheme:
Lectures: 3 Hrs/week

Examination scheme:
In semester exam: 30 marks---1 Hr.
End semester exam: 70 marks—2.5 Hrs.

Unit I

Introduction to earthquakes: **(6 Hrs.)**

Geology of earth, configuration of tectonic plates in a globe, influence of Geology on earthquake, behavior of plates, their motion and effects, causes of earthquake and their Characteristics, Earthquake parameters, magnitudes, intensity, scales, classification of earthquake seismic zoning of India, seismic coefficients for different zones, .Lessons from past earthquake: - Study of damages caused due to past, earthquakes in/ outside India and remedial measures.

Unit II **(6 Hrs.)**

Theory of vibrations:

Vibrations - definition, causes, classifications. Single Degree of Freedom systems (SDOF) - Free, forced, damped, un-damped vibrations with basic examples. Introduction to Multi-degrees of Freedom systems (MDOF) - derivations of related equations and solutions to two degree and three degree of freedom systems.

Unit III **(6 Hrs.)**

Static analysis of earthquake forces:

Introduction to IS1893 (Part-I): Seismic design Philosophy, provision, Seismic coefficient method.

Unit IV **(6 Hrs.)**

Dynamic analysis of earthquake forces:

Response Spectra, estimation of story shear, effect of unsymmetrical geometry and masses, mass center and stiffness center, estimation of story shear for symmetrical and torsion for unsymmetrical buildings. Effect of infill masonry and shear walls.

Unit V **(6 Hrs.)**

Earthquake force calculation and analysis and design of frames

Estimation of combined effect of lateral forces and vertical loading on multi storeyed frames. Design any intermediate continuous beam of the frames for combined effect of loadings, Concept of ductile detailing, IS 13920 provisions for RC frame.

Unit VI **(6 Hrs.)**

Introduction of different control systems: Passive control: base isolation and active control: bracing system. Strengthening and Retrofitting techniques, methodology of retrofitting for walls, slabs roofs columns, foundations etc. for buildings in stones, bricks, RCC. Introduction to Disaster Management: Types of Disaster, Phases of disaster management, Disaster rescue, psychology and plan of rescue operations.

Notes:

Every design should confirm to latest versions of IS 1893, 4326, 13920, 13827, 13828, 13935

Text Books:

1. Earthquake resistance design of structure by Duggal- Oxford University Press.
2. Earthquake – Resistant Design of Building Structures-Dr. Vinod Hosur-- Wiley India.
3. Earthquake Tips NICEE, IIT, Kanpur.
4. Elements of Earthquake Engineering by Jaikrishna and Chandarsekaran.
5. Earthquake resistant design of structures- Agarwal, Shrikhande, PHI learning.

Reference Books:

1. Dynamics of structure by Clough R.W. and Penzin J. McGraw Hill Civil Engineering Series.
2. Dynamics of structure by Anil Chopra, Prentice Hall India Publication.
3. Dynamics of structure by Mario Paz, CBSPD Publication.
4. Geo-technical Earthquake Engineering by Kramer S. L. Prentice Hall India Publication.
5. Introduction to Structural Dynamics by John M. Biggs.
6. Mechanical Vibrations by V. P. Singh.
7. Relevant Latest Revisions of IS codes.

401 005 Elective II (5)- Advanced Geotechnical Engineering

Teaching scheme:
Lectures: 3 hours/week

Examination scheme:
In semester exam: 30 marks---1 hour
End semester exam: 70 marks—2.5 hours

Unit I **(6 Hrs.)**

(a) Soil classification Identification and classification, criteria for classifying soil - classification on the basis of grain size, plasticity, symbolic & graphic presentation. Classified soils and engineering properties. (b) Soil structure & clay minerals Clay minerals, clay water relations, clay particle interaction, soil structure & fabric, granular soil fabric.

Unit II **(6 Hrs.)**

(a) Earth pressure theory Earth pressure theories for calculation of active and passive pressure, Rankines and coulombs earth pressure theories, analytical and graphical methods. (b) Design of earth retaining structures Design of gravity and cantilever retaining walls, design - cantilever sheet pile walls, anchored sheet pile walls, timbering and bracing for open cuts.

Unit III **(6 Hrs.)**

(a) Geosynthetics Geosynthetics- types, functions, properties and functional requirements. Application of geosynthetics in geoenviroment. (b) Reinforced soil Mechanism, reinforcement soil – interaction. Applications – reinforcement soil structures with vertical faces, reinforced soil embankments. Reinforcement soil beneath unpaved roads, reinforcement of soil beneath foundations. Open excavation and slope stabilization using soil nails.

Unit IV **(6 Hrs.)**

(a) Soil behavior under dynamic loads Soil behavior under static and dynamic loads. Acceptable levels of strain under static and dynamic loading. Soil properties relevant for dynamic loading and its determination.
(b) Machine foundations: Types of machine foundations, design criteria, methods of analysis – elastic half space method, linear elastic weightless spring method. Evaluation of soil parameters. Design procedure for a block foundation for cyclic loading and impact loading.

Unit V **(6 Hrs.)**

Ground Improvement In-situ ground improvement by compaction piles, dynamic loads, sand drains, grouting, deep mixing, inserting reinforcement elements, freezing soil, and vibroflotation.

Unit VI **(6 Hrs.)**

Rheology Rheological elements, basic and composite rheological models. Examples of compound models used to explain different soil phenomena; such as secondary consolidation, creep etc.

Reference Books:

1. Physical and Geotechnical properties of soils- Joseph E. Bowels, Tata Mac-Grawhill.
2. Advance Soil Mechanics – Braja Mohan Das- Tata Mc- Grawhill.
3. Geotechnical Engineering by Shashi K. Gulati & Manoj Datta – Tata Mc-Grawhill.
4. Basic and Applied Soil Mechanics- Gopal Ranjan & A.S. Rao- New Age Publication.

Codes:

1. I.S .Codes 1. IS: 1892-1979 – "Code of Practice for Subsurface Investigation for Foundation".
2. 2. IS: 2131-1981 (Reaffirmed 1997), "Method for Standard penetration Test for Soils".

Handbooks:

1. Bolt, Bruce A.(1999),"Earthquakes", W. H. Freeman.
2. Baghi, A., (1994)" Design, Construction and Monitoring of Landfills." John Wiley & Sons.
3. Day. R.W.(2002),"Geotechnical Earthquake Engineering Handbook",McGraw Hill.

e -Resources:

1. Website www.nptel.iitm.ac.in

401006 Project Phase-I

Teaching Scheme: **Examination Scheme:**

Tutorial: 2 Hrs/week **TW: 50 Marks.**

Project phase I Term Work will be evaluated for an individual student based on the seminar presented on the work done in first semester and submission of the report. If the student fails to present the seminar and submit the report, he / she will be marked absent in project examination. The project work phase I shall be consist of any one of the following nature in Civil Engineering related subjects.

1. Experimental investigation.
2. Software development.
3. Benefits cost economic analysis.
4. Case study with own design.
5. Working model design and fabrication.
6. Case study with development of methodology using soft computing tools.

It is mandatory to present a seminar in presence of Internal and External Examiners and submit preliminary project report based on work done in first semester. The report shall contain finalization of topic, literature survey, planning schedule/ flow chart for completion of project. The report shall be typed or printed and hard/spiral bound. The project work to be taken up individually or in groups. The group shall not be of more than 4 students. References shall be mentioned at the end as per universal standards as mentioned in any international journal of professional body.

Format of project report: Sequence of pages:

i) Front Cover Page ii) Certificate iii) Acknowledgement iv) Synopsis v) Contents vi) Notations vii) List of Tables viii) List of Figures ix) List of Graphs.

Chapter 1 Introduction (This consists of: 1.1 Introduction of the Project Work; 1.2 Problem Statement, 1.3 Objectives and 1.4 Scope of the Project Works, 1.5 Research Methodology, 1.6 Limitations of study, 1.7 Expected outcome.

Chapter 2 Literature Review from minimum 10 articles (It shall include theoretical support, details regarding work done by various persons, methods established, any new approach. It should preferably highlight the development in the field of research chronologically as reflected from books, journals etc.).

Chapter 3 Planning Schedule/ Flow Chart For Completion of Project References and Bibliography (The references and bibliography shall include name of author/code/manual/book, title of paper/code/manual/book, name of the journal, month & year of publication, volume number/ISBN number, page number x-y. The references and bibliography shall be as per universal standards as mentioned in any international journal of professional body).

Report Printing details:

1. Report shall be typed on A4 size Executive Bond paper with single spacing preferably on Both sides of paper.
2. Margins: Left Margin: 37.5 mm, Right Margin: 25 mm, Top Margin: 25 mm, Bottom Margin: 25 mm.
3. Give page number at bottom margin at center.
4. Size of Letters: Chapter Number: 16 font size, Times New Roman in Capital Bold Letters, Chapter Name: 12 Font size in Capital Bold Letters, Main Titles (1.1, 2.5 etc): 16 Font size in Bold Letters Sentence case, Sub Titles (1.1.5, 4.5.1 etc): 14 Font size in Bold Letters-Sentence case. All other matter: 12 Font size sentence case.
5. No blank sheet be left in the report.
6. Figure name: 12 Font size in sentence case Bold- Below the figure.
7. Table title -12 font size in sentence case- Bold-Above the table.

Semester-II

Savitribai Phule Pune University Board of Studies in Civil Engineering B.E. Civil 2015 Course (w. e. f. June 2018)

401007 Dams and Hydraulic Structures

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hours/week	**In-sem: 30 marks (1 Hour)**
Practical: 2 hours/week	**End-sem :70 marks (2.5 Hours)**
	Oral : 50 marks

Unit I **(4 Hrs.)**

a) Introduction to dams

Introduction, Historical development of dams, Different terms related to dams, Selection of site for dam, Factors governing selection of type of dam, Classification of dams, Classification based on purpose, Classification based on materials, Classification based on size of project, Classification based on hydraulic action, Classification based on structural action, Dams and earthquakes, Dams and social issues, Large dams verses small dams, Displacement and rehabilitation, Dams and climate change.

b) Dam Safety and Instrumentation

Introduction, Objectives of dam safety and instrumentation, Types of measurements, Instrumentation data system, Working principles and functions of instruments, Selection of Equipment’s, Different Instruments, Piezometers, Porous tube piezometer, Pneumatic piezometer, Vibrating wire piezometer ,Settlement measurement system Vibrating wire settlement cell, Magnetic settlement system, Inclinometer, Joint meter, Pendulums, Inverted Pendulum, Hanging Pendulum, Automatic pendulum coordinator ,Vibrating wire pressure cell, Extensometer, Embedment strain gauge, Temperature gauge, distributed fiber optics temperature tool, seismograph.

UNIT 2 **(7 Hrs.)**

a) Gravity Dams

Introduction, Components of gravity dam, Conditions favoring gravity dams, Forces acting on gravity dam, Combinations of loading for design, Seismic analysis of dam, Terms related to seismic analysis, Determination of Seismic forces (Zangar’s method) , Effect of horizontal earthquake acceleration, Effect of vertical earthquake acceleration, Stress analysis in gravity dam (Only concept, no derivations), Vertical or normal stress , Principal stresses, Shear stress, Middle third rule, Modes of failure of gravity dam, Elementary profile of gravity dam, Concept of low and high gravity dams, Various Design methods of gravity dam (Introduction only)— Details of Gravity method or 2 D method, ,Construction of gravity dams, Colgrout masonry, Roller Compacted Concrete (R.C.C.),Temperature control in mass concreting, Crack formation in gravity dam, Control of crack formation in dams, Construction joints, Keys, Water seal, Retrofitting.

b) Arch Dam and Other Dams (Introduction only)

Introduction, Concept of Arch Dam, Conditions favoring an arch dam, Classification of an arch dam, Constant angle arch dam, Constant radius arch dam, Variable radius arch dam, Arch gravity dam, Double curvature arch dam, Buttress dams, Advantages of Buttress dams, Limitations of Buttress dams, Types of buttress dams.

Unit III **(7 Hrs.)**

a) Spillway and Gates [6 Lectures]

Introduction, Location of Spillway, Different key levels and heads in spillway, Spillway Capacity, Components of spillway, Approach channel, Control structure, Discharge channel, Energy dissipation device, Tail channel, Classification of spillway, Classification based on operation, Main or service spillway, Auxiliary spillway, Emergency spillway, Classification based on gates, Gated spillway, Ungated spillway, Classification based on features, Straight drop spillway(Free overflow spillway),Saddle spillway, Side channel spillway, Overflow or ogee spillway, Chute or open channel or trough spillway, Shaft or morning glory spillway, Siphon spillway, Conduit or tunnel spillway, Stepped spillway,

Design of Ogee spillway or overflow spillway, Shape of crest, Equations for spillway profile on upstream and downstream, Energy dissipation below spillway, Classification of energy dissipation devices, Energy dissipation in stilling basin, Stilling basin, Components of stilling basin, Types of stilling basins, Indian standard stilling basins, Energy dissipation through buckets, Solid roller bucket, Slotted roller bucket, Ski jump bucket, Correlation between jump height and tail water depth.

b) Spillway Gates

Introduction of Spillway gates , Classification of spillway crest gates, Classification based on function, Classification based on movement of gates, Classification based on special features, Introduction to automatic gates, Maintenance of gates, Inspection of gates.

Unit IV **(7 Hrs.)**

a) Earth Dam

Introduction, Conditions favoring an earth dam, Limitations of earth dam, Classification of earth dam, Classification based on---materials, method of construction, height; Selection of type of earth dam, Components of an earth dam, Requirements for safe design of earth dam, Hydraulic (Seepage) Analysis, Plotting of seepage line, Case 1: Homogeneous earth dam with horizontal drainage blanket, Determination of seepage discharge using phreatic line.

Case II: Composite earth dam with casing and hearting, Properties of phreatic line, Determination of seepage discharge through earth dam using flownet, Structural stability analysis of homogeneous and zoned earth dam, Forces acting on earth dam, Method of stability analysis of an earth dam, Procedure of analysis by Swedish slip circle method, Fellenius Method of Locating Centre of Critical Slip circle, Stability analysis for foundation, Failure of earth dam, Classification of failure of earth dams, Hydraulic Failure, Seepage failure, Structural failure, Seepage control in earth dams, causes of seepage, Seepage control measures, Construction of earth dam,

b) Diversion head works

Introduction, Function of diversion headworks, Selection of site for diversion headworks, Layout of diversion headworks, Components of diversion headworks, Design of weir on permeable foundation, Criteria for safe design of weir floor, Brief introduction to Bligh and Lane’s theory, Khosla's theory based on potential theory approach, Khosla's theory of independent variables, Design criteria of weirs on permeable foundations, Checks for stability and safety of weirs.

Unit V **(6 Hrs.)**

a) Canals

Introduction, Classification of canals, Classification based on alignment, Classification based on soil, Classification based on source of supply, Classification based on discharge, Classification based on lining, Classification based on excavation, Components of canal , Data required for canal design, Selection of canal alignment, Design of stable canal in alluvial beds, Kennedy’s theory, Design of canal by Kennedy’s theory, Limitations of Kennedy’s theory, Lacey’s regime theory, Design of canal by Lacey’s theory, Canal lining, Need of canal lining, Requirements of lining material, Classification of canal lining, Hard surface lining including Ferrocement lining, Soft surface lining, Burried lining, Advantages of canal lining, Design of lined canal, Benefit – cost analysis for canal lining.

b) Canal Structures

Canal falls Introduction, Necessity of canal fall, Selection of site for canal fall, Classification of canal fall, Types of falls, Free fall or open fall, Notch fall, Ogee Fall, Rapid Stepped fall, Straight glacis fall, Sarda fall, Semi pressure fall, Baffle or Englis Fall, Montague fall Siphon well or cylinder fall, Pressure or closed conduit fall, Shaft or Pipe fall, Selection of type of fall, **Canal outlets-** Introduction of Canal outlet or module, **Canal escapes-** Introduction of Escapes, Significance of canal escape, **Canal regulators--**Canal regulators.

Unit VI **(5 Hrs.)**

a) C. D. Works

Introduction, Necessity of cross drainage works, Selection of site for Cross Drainage work, Data required for design of Cross Drainage work, Classification of Cross Drainage works, Drain over canal-Siphon, Super passage, Canal over drain—Aqueduct, Siphon aqueduct, Canal and drain water mixed in each other--Level crossing, Inlet and Outlet, Selection of suitable type of C. D. works, Design considerations for cross drainage works.

b) River Training Structures

Introduction, Classification of rivers, Classification based on topography, regime, alignment, source, Behaviour of rivers, River training, Objectives of river training, Classification of river training, purpose, orientation, River training structures, Embankment or Levee, Guide banks, Groynes or spurs, Artificial cut off, Pitched island, Submerged sill or dykes, Closing dykes.

Term Work (A+B+C)

A) Analysis /Design Assignments. (Compulsory)

1) Stability analysis of gravity dam
2) Design of profile of spillway and energy dissipation device below the spillway
3) Stability analysis of zoned earthen dam
4) Analysis of weirs on permeable foundations.
5) Design of unlined and lined canal.

B) Site visits and reports with photographs (compulsory)

1. Gravity dam.
2. Earth dam.
3. D. work/ Canal structure(s)/Weirs/Barrage.

C) Review of any one case study of failure of hydraulic structure from the published literature or patent related to Hydraulic structures (in a group of five students).

Note:-

Visit report should consist of Name of project, date of visit , need and practical significance of project, salient features of project, technical details of project, detailed description and figures of different components of project, special features of project, the technical, social, financial and environmental impact of project on downstream and upstream, photographs of technical details of visit, if allowed . If not allowed for technical details, the photograph near board of project or site as a proof of visit.

Reference Books :-

1. Design of Small Dams- United States Department of the Interior, Bureau of Reclamation revised reprint 1974, Oxford and IBH Publishing Co.
2. Irrigation and Water Resources Engineering- Asawa G.L- New Age International (P) Ltd. Publishers, first ed, 2005.
3. Irrigation Engineering and Hydraulic Structures- Garg S.K- Khanna Publishers N.D. 13th ed, 1998.
4. Design Textbook in Civil Engineering: Volume Six: Dams- Leliavsky, Serge – Oxford and IBH Publishing Co. Pvt. Ltd., 1981.
5. Roller Compacted Concrete Dams- MehrotraV.K- Standard Publishers Distributors, Delhi, 1st ed, 2004.
6. Irrigation, Water Resources and Water Power Engineering- Modi, P.N. - Standard Book House, New Delhi, 2nd ed, 1990.
7. Irrigation and Water Power Engineering - Punmia B.C. - Laxmi Publication.

I.S. Codes:

1. I.S. 8605 – 1977 (Reaffirmed 1998), Code of practice for construction of masonry in dams, third reprint, July 1999, B.I.S. New Delhi.
2. I.S. 6512-1984 (Reaffirmed 1998), Criteria for design of solid gravity dams, first revision, first reprint, September, 1998, B.I.S. New Delhi.
3. I.S. 457 – 1957 (Reaffirmed, 2005), Code of practice for general construction of plain and reinforced concrete for dam and other massive structures, sixth reprint, January 1987, B.I.S. New Delhi.

4. I.S. 10135 – 1985, Code of practice for drainage system for gravity dams, their foundations and abutments, first revision, B.I.S. New Delhi.
5. I.S. 14591 – 1999, Temperature control mass concrete for dams – guidelines, B.I.S.
6. I.S. 11223 – 1985 (Reaffirmed 2004), Guidelines for fixing spillway capacity, edition 1.2 (1991-09), B.I.S. New Delhi.
7. I.S. 6934 – 1998 (Reaffirmed 2003), Hydraulic design of high ogee overflow spillways – recommendations, first revision, B.I.S. New Delhi.
8. I.S. 11155- 1994, Construction of spillways and similar overflow structures – Code of practice, B.I.S. New Delhi.
9. I.S. 5186 – 1994, Design of chute and side channel spillway – criteria, first revision, B.I.S. New Delhi.
10. I.S. 10137- 1982 (Reaffirmed 2004), Guidelines for selection of spillways and energy dissipaters, B.I.S. New Delhi.
11. I.S. 4997 – 1968 (Reaffirmed 1995) Criteria for design of hydraulic jump type stilling basins with horizontal and sloping apron, sixth reprint, January, 1998, B.I.S. New Delhi.
12. I.S. 7365-1985, Criteria for hydraulic design of bucket type energy dissipaters, first revision, B.I.S. New Delhi.

01 008 Quantity Surveying, Contracts & Tenders

Teaching scheme:
Lectures: 3 Hrs/week
Practical: 2 Hrs/week

Examination scheme:
In semester exam: 30 Marks---1 Hr.
End semester exam: 70 Marks—2.5 Hrs.
Oral: 50 Marks

Unit I **(6 Hrs.)**

Introduction and Approximate Estimates:

a) **Introduction to estimates and related terms:** Definition of estimation and valuation. Significance (application) of the Course. Purpose of estimation. Type of estimates, data required for estimation as a pre requisite. Meaning of an item of work, and enlisting the items of work for different Civil Engineering projects. Units of measurement. Mode of measurement of building items/ works. Introduction to components of estimates: face sheet, abstract sheet (BOQ), measurement sheet, Rate Analysis, lead statement. Provisional sum& prime cost items, contingencies, work charge establishment, centage charges. Introduction to D. S. R.

b) **Approximate Estimates**: Meaning, purpose, methods of approximate estimation of building & other civil engineering projects like roads, irrigation/ water supply, sanitary engineering, electrical works.(Theory & Numericals).

Unit-II **(6 Hrs.)**

Taking out quantities &Detailed estimate:

a) Detailed estimates: Factors to be considered while Preparing Detailed Estimate, Detailed estimate of R.C.C framed structures using IS 1200, Concept of Estimation of Load Bearing Structure (PWD & Centre Line Method).

b) **Bar Bending Schedule:** Preparing Bar Bending Schedule for all RCC members of building.

Unit-III **(6 Hrs.)**

Specifications and Rate Analysis:

a) Specifications: Meaning & purpose, types. Drafting detailed specifications for materials, quality, workmanship, method of execution, mode of measurement and payment for major items like, excavation, stone/ brick masonry, plastering, ceramic tile flooring, R.C.C. work.

b) Rate Analysis: Meaning and factors affecting rate of an item of work, materials, sundries, labour, tools & plant, overheads & profit. Task work or out turn, factors effecting task work. Working out Rate Analysis for the items mentioned in specifications above.

Unit IV **(6 Hrs.)**

Valuation:

a) **Valuation:** Purpose of valuation. Meaning of price, cost and value. Factors affecting

'Value'. Types of value: only Fair Market Value, Book Value, Salvage/ Scrap Value, Distressed Value and Sentimental Value. Concept of free hold and lease hold property. Estimation versus valuation. Methods of depreciation & obsolescence, Sinking Fund, Years Purchase.

b) **Methods of Valuation of Building:** Rental Basis, Land & Building basis, Direct Comparison Method, Profit based method, Belting of Land, Development method.

Unit V **(6 Hrs.)**

Tendering and Execution of Works:

a) Tenders: Definition. Methods of inviting tenders, tender notice, tendering procedure,
Pre and post qualification of contractors, tender documents. 3 bid/ 2 bid or single bid system. Qualitative and quantitative evaluation of tenders. Comparative statement, Pre-bid conference, acceptance/ rejection of tenders. Various forms of BOT &Global Tendering, E-tendering.

b) Methods of Executing Works: PWD procedure of work execution, administrative approval, budget provision, technical sanction. Methods of execution of minor works in PWD: Piecework, Rate List, Daily Labour. Introduction to registration as a contractor in PWD.

Unit VI **(6 Hrs.)**

Contracts and Arbitration:

a) Contracts: Definition, objectives & essentials of a valid contract as per Indian Contract

Act (1872), termination of contract. Types of contracts: only lump sum, item rate, cost plus. **Conditions of contract**: General and Specific conditions. Conditions regarding EM, SD, and time as an essence of contract, conditions for addition, alteration, extra items, testing of materials, defective work, subletting, etc. Defect liability period, liquidated damages, retention money, interim payment or running account bills, advance payment, secured advance, final bill.

b) **Arbitration**: Introduction to Arbitrations as per Indian Arbitration & Conciliation Act (1996) Meaning and need of arbitration, qualities and powers of an Arbitrator.

Term Work:

The following exercises should be prepared and submitted:

1. Report on contents, use of current DSR & Drafting detailed specification for major items of works.
2. Working out quantities using C-L and PWD method for a small single storied load bearing structure up to plinth and Preparing Abstract Sheet using DSR(Regional)
3. Detailed Estimate of a single storied R.C.C framed building using D.S.R.
4. Working out quantities of steel reinforcement for a column footing, a column, a beam and a slab by preparing bar bending schedule.
5. Working out rate analysis for the items as in the specifications of Assignment No. 1.
6. Preparing Valuation of a Residential building and writing report using O-1 form.
7. Estimating quantities for any one of the following using appropriate software.
   a) A Factory Shed of Steel Frame
   b) Underground Water Tank
   c) Pipe Culvert
   d) Road / Railway Track/ Runway
8. Drafting of tender notice, Preparation of Schedule A & B and Conditions of Contract regarding time, labour payment, damages for RCC Framed Structure (Assignment No. 3) and collecting minimum of 3 tender notices of Civil Engineering Works.

Oral Examination: Based on the Term Work.

Reference Books:

1. Estimating and Costing in Civil Engineering: Theory and Practice: B.N Dutta - S. Dutta & Company, Lucknow.
2. Estimating, Costing Specifications & valuation in Civil Engineering: M. Chakraborty.
3. Estimating and Costing: R. C. Rangwala - Charotar Publ. House, Anand.
4. Theory and Practice of Valuation: Dr. RoshanNamavati, Lakhani Publications.
5. Valuation Principles and Procedures: Ashok Nain, Dewpoint Publ.
6. Laws for Engineers : Dr. Vandana Bhat and Priyanka Vyas –Published by PRO-

CARE,5/B,/Sagarika Society,Juhu Tara Road,Juhu,Santacruz(W),Mumbai-400049 procure@technolegal.org).

Handbooks:

1. Standard Contract Clauses for Domestic Bidding Contracts: Ministry of Statistics and Program Implementation, Government of India.
2. FIDIC Document: Federation International Des Ingenieurs Conseils i.e. International Federation of Consulting Civil Engineers, Geneva, Switzerland.
3. Indian Practical Civil Engineers' Handbook: P. N. Khanna, UBS Publi. Distri. Pvt. Ltd. (UBSDP).

Codes:

1. IS 1200 (Part 1 to 25): Methods of Measurement of Building & Civil Engg.Works.
2. IS 3861-1966: Method of Measurement of Areas and Cubical Contents of buildings.
3. D. S. R. (District Schedule of Rates) for current year.
4. PWD Redbooks, Vol 1 & 2.

e – Resources: nptel.iitm.ac.in

401 009 Elective III (1) Advanced Structural Design

Teaching Scheme
Lectures: 3 hours/week
Practical: 2 hours/week

Examination Scheme
Theory Examination:
In-sem : 30 marks (1 Hour)
End-sem:70 marks (2.5.Hours)
Term work: 50 Mark

Unit 1 **(6 Hrs.)**

Cold-formed light gauge steel structural members: Design of axially loaded compression members, tension members and beams (not more than two spans).

Unit 2 **(6 Hrs.)**

Frames: Uniqueness theorem, lower bound and upper bound theorems, mechanisms, analysis and design of frames (single story), design of connections.

Unit 3 **(6 Hrs.)**

Composite deck slab: Design of composite deck slab with cold form light gauge profile and shear connectors.

Unit 4 **(6 Hrs.)**

Yield line analysis and design of slabs: Yield line theory, yield lines, ultimate moment along a yield line, principle of virtual work, analysis and design of slabs of different geometry, support conditions and loading conditions.

Unit 5 **(6 Hrs.)**

Elevated water tanks: Analysis and design for gravity and earthquake loads (static analysis) for square, rectangular and circular water tanks (excluding Intze tank) supported on staging, design of staging and foundation system.

Unit 6 **(6 Hrs.)**

Shear walls: Function, types, analysis and design of cantilever type shear walls.

Note: The designs should conform to the latest codal provisions.

Term Work:

a) At least three plates showing the details of cold-formed light gauge steel sections used in compression, tension and flexural members

b) At least three plates showing the details based on yield line analysis and design of slabs

c) Sheet 1: Detailing of any one design problem from Unit 2 or Unit 3

d) Sheet 2: Detailing of any one design problem from Unit 5 or Unit 6

e) Report of two site visits covering the contents of the syllabus mentioned above.

References:

1). Design of Steel Structures, Ramachandra, Standard Publications New-Delhi

2). Structural and Stress Analysis, T.H.G. Megson, Butterworth-Heinemann

3). Design of Concrete Structures, J. N. Bandyopadhyay, PHI

4). Punmia, Reinforced Concrete Structures Vol. 1 and 2, Standard Book House NewDelhi.

5). Sinha and Roy., RCC Analysis and Design . S. Chand and Co. New-Delhi

6). Ramachandra, Design of Steel Structures Vol.-II Standard Publications New-Delhi.

7). Punmia,B. C. and Jain and Jain, Comprehensive Design of Steel Structures, Standard Book House

8) INSDAG publications

401009 Elective=III (2) Statistical Analysis and Computational Methods in Civil Engineering

Teaching Scheme
Lectures : 3 hours/week
Practical: 2 hours/week

Examination Scheme
In-sem : 30 marks (1 Hour)
End-sem:70 marks (2.5.Hours)
Term work: 50 Mark

Unit I: (6 Hrs.)

Numerical methods: Bisection method, False Position method, Newton Raphson, Secant method.

Unit II: (6 Hrs.)

Numerical Integration Need and scope, trapezoidal rule, Simpsons 1/3rd rule, Simpsons 3/8th rule, Gauss Quadrature method.

Unit III: (6 Hrs.)

Optimization techniques: Introduction to optimization techniques-concepts and applications, direct solution of linear equations-Gauss elimination and Gauss Jordon method. Iterative solution of linear equations- Gauss Seidel method.

Unit IV: (6 Hrs.)

Statistical methods: Introduction, collection, classification and representation of data, measures of central value (mean, median, mode), measures of dispersion, sampling.

Unit V: (6 Hrs.)

Probability and Probability distributions including Binomial, Poisson, Normal, test of hypothesis, chi-square test.

Unit VI: (6 Hrs.)

Correlation analysis, regression analysis. Coefficient of correlation, probable error, single and multiple regression, curve fitting, Interpolation and extrapolation.

Term Work:

1. One exercise on each unit.
2. Any two problems to be solved using c, c++, excel or using softwares like SPSS, minitab, etc.
3. One exercise on formulation and solution of an optimization problem applicable to any field of Civil Engineering.

Reference Books:

1. Statistical methods – S.P.Gupta.
2. Probability and Statistics for Engineers – Richard A Johnson 3. Probability and Statistics for Science and Engineering – G Shankar Rao.
4. Numerical Methods – E Balagurusamy.
5. Numerical methods for Engineers – S. Chapra, R.P.Canale.
6. Higher Engg. Mathematics – B.S. Grewa.

401009 Elective III (3): Hydro Power Engineering

Teaching Scheme
Lectures: 3 hours/week
Practical: 2 hours/week

Examination Scheme
Theory Examination
In-sem: 30 marks (1 Hour)
End-sem:70 marks (2.5.Hours)
Term work: 50 Marks

Unit I **(6 Hrs.)**

Energy Resources – Planning and Potential:

Power resources – Conventional and Nonconventional, Need and advantages, Overview of World Energy Scenario, energy and development linkage, Environmental Impacts of energy use, Green House Effect, Trends in energy use patterns in India, Hydropower development in India, Hydropower potential basin wise and region wise, investigation in hydropower plants.

Unit II **(6 Hrs.)**

Hydropower Plants:

Hydrological Analysis, Classification of hydropower plants based on hydraulic characteristics - Run of river plants, Storage or Valley dam plants, Pumped storage plants, Classification based on head, Classification based on operating function, Classification based on plant capacity, Classification based on nature of topography, Introduction to micro hydro, advantages and disadvantages, Principle Components of hydropower plants.

Unit III **(6 Hrs.)**

Load Assessment:

Estimation of electrical load on turbines. Load factor, Plant factor, peak demand and utilization factor, installed capacity, diversity factor, firm power, secondary power, load curve, load duration curve, Prediction of load and significance, Tariffs, Hydro-Thermal Mix, Combined Efficiency of Hydro-Thermal-Nuclear Power Plants.

Unit IV **(6 Hrs.)**

Water Conductor System and Powerhouse:

Water Conductor System – Alignment, Intake Structures- Location and Types, Trash Rack. Headrace tunnel/ Canal, Penstock and pressure shaft, Types of Powerhouses, Typical layout of powerhouse, Components, Power plant equipments, Instrumentation and control.

Unit V **(6 Hrs.)**

Turbines:

Classification, Principles and design of impulse and reaction turbines, Selection of Turbine, Specific Speed, Governing of turbines, Water hammer, Hydraulic Transients and Surge tanks, Draft tubes, Cavitation.

Unit VI **(6 Hrs.)**

Economics of Hydroelectric Power:

Hydropower - Economic Value and Cost and Total Annual Cost. Economic considerations – pricing of electricity, laws and regulatory aspects, Policies, Electricity act – 2003, Investment in the power sector, Carbon credits, Participation of private sector.

Term Work:

Minimum eight assignments as per the list given below. **Assignments 1 and 10 are compulsory.**

1. Calculating the electricity bill of upper middle class family that uses various electrical appliances.
2. Determination of power output for a run of river plant with and without pondage.
3. Justification of economics of Pumped storage plants.
4. Design of Kaplan / Francis / Pelton turbine.
5. Determination of diameter of penstock using different methods.
6. Design of surge tank.
7. Design of straight conical draft tube.
8. Use of any software to calculate water hammer pressure.
9. Case study of any hydropower project.
10. Report based on visit to any micro/small/mega hydropower project

Reference Books:

1. Water Power Engineering – M. M. Dandekar and K. N. Sharma, Vikas Publishing House.
2. Water Power Engineering – R. K. Sharma and T. K. Sharma, S. Chand and Co. Ltd.
3. Handbook of Hydroelectric Engineering – P.S. Nigam
4. Modern Power System Planning – Wang.
5. Hydropower Resources in India – CBIP.

6. Hydro Power Structures – R. S. Varshney.
7. Water Power Development – E. Mosonvi, Vol. I & II.
8. Hydro-electric Engineering Practice – G. Brown, Vol. I, II & III.
9. Hydro – Electric Hand Book – Creager and Justin.
10. Water Power Engineering – P. K. Bhattacharya, Khanna Pub., Delhi.
11. Water Power Engineering – M. M. Deshmukh, Dhanpat Rai Pub.
12. Manual of "Energy Group" of 'PRAYAS', an NGO.

401009 Elective-III: (4) Air Pollution and Control

Teaching Scheme:
Lectures: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Paper In-sem. 30 Marks (1 hr),
Paper End-sem : 70 Marks (2.5 hrs)
TW : 50 Marks

Unit I **(6 hrs)**

Meteorological aspects: Zones of atmosphere, Scales of meteorology, Meteorological parameters, Temperature lapse rate, Plume behaviour. Gaussion diffusion model for finding ground level concentration, Plume rise, Types & quality of fuels, Formulae for effective stack height and determination of minimum stack height as per CPCB norms.

Unit II **(6 hrs)**

Ambient Air sampling and analysis: Air pollution survey, basis and statistical considerations of sampling sites, devices and methods used for sampling of gases and particulates. Stack emission monitoring for particulate and gaseous matter, isokinetic sampling. Analysis of air samples chemical and instrumental methods. Emission inventory and source apportionment studies. Ambient air quality monitoring as per the procedure laid down by CPCB. National Ambient Air Quality Standards (NAAQS) 2009.

Unit III **(6 hrs)**

Indoor air pollution: Causes of air pollution, sources and effects of indoor air pollutants, factors affecting exposure to indoor air pollution, sick building syndrome. Investigation of indoor air quality problems, changes in indoor air quality, control of indoor air pollutants and air cleaning systems. Use of various plants to control indoor air pollution. Radon and its decay products in indoor air.

Odour pollution: Theory, sources, measurement and methods of control of odour pollution.

Unit IV **(6 hrs)**

Control of air pollution: By process modification, change of raw materials, fuels, process equipment and process operation. Control of particulate matters. Working principle and design of control equipment as Settling chamber, Cyclone, Fabric filter and Electro Static Precipitator. Control of gaseous pollutants. Combustion chemistry & control of air pollution from automobiles.

Unit V **(6 hrs)**

Land use planning: As a method of control. Economics of air pollution control: Cost/benefit ratio and optimization. Legislation and regulation: Air (Prevention and Control) Pollution Act, 1981. The Environment (Protection) Act 1986. Emission standards for stationary and mobile sources.

Unit VI **(6 hrs)**

Environmental impact assessment and management: Methodology for preparing environmental impact assessment (Identifying the sources of air pollution, calculating the incremental values, prediction of impacts and mitigation measures). Role of regulatory agencies and control boards in obtaining environmental clearance for project. Public hearing. Environmental impacts of thermal power plants, sugar and cement industry. Environmental management plan. The environmental rules 1999 (sitting of industries).

Term Work:

Term work shall consist of

A. One assignment on each unit.
B. Detailed industrial visit report on Sugar/Cement/Steel//Thermal/Rubber/Dairy industry with reference to air pollution Control device(s).

Reference Books:

1. Air Pollution – H. V. N. Rao and M. N. Rao, TMH, Pub.
2. Air pollution – KVSG Murali krishna.
3. Air Pollution – Perkins.
4. Environmental Engineering – Davis, McGraw Hill- Pub.
5. Environmental Engineering – Peavy H.S and Rowe D.R, McGraw Hill- Pub.
6. Air Pollution – Stern.
7. Air Pollution Control – Martin Crawford.
8. Air Pollution Control: its origin and control, K. Wark, C.F. Warner & W.T.Davis .
9. Fundamentals of Air Pollution-Richard W. and Donald L. Academic Press.

I.S. Codes:

1. I.S. 5182 (all parts), and
2. I.S. 15442 (2004)

e – Resources:

1. http://nptel.iitm.ac.in/courses-contents/IIT Kanpur and IIT Madras.
2. http://cpcb.nic .in
3. http://moef.nic .in

401009 Elective III (5): Finite Element Method in Civil Engineering

Teaching Scheme:
Lectures: 3 hours/week
Practical: 2 hours/week

Examination Scheme:
Theory Examination:
In-sem: 30 marks (1 Hour)
End-sem:70 marks (2.5.Hours)
Term work: 50 Mark

Unit I **(6 Hrs.)**

Theory of elasticity: Strain-displacement relations, compatibility conditions in terms of strain, plane stress, plane strain and axisymmetric problems, differential equations of equilibrium, compatibility condition in terms of stresses, stress-strain relations in 2D and 3D problems.

Unit II **(6 Hrs.)**

General steps of the finite element method, Applications and advantages of FEM, concept of finite element for continuum problems, discretisation of continuum, use of polynomial displacement function, Pascal's triangle, convergence criteria.

Principle of minimum potential energy, formulation of stiffness matrix for truss element using variational principles.

Unit III **(6 Hrs.)**

Displacement function for 2D triangular (CST and LST) and rectangular elements, Use of shape functions, Area co-ordinates for CST element, Shape functions in cartesian and natural coordinate systems, shape functions for one dimensional element such as truss and beam, shape functions of 2D Lagrange and serendipity elements.

Unit IV **(6 Hrs.)**

Introduction to 3D elements such as tetrahedron and hexahedron. Iso-parametric elements in 1D, 2D and 3D analysis, Jacobian matrix, Formulation of stiffness matrix for 1D and 2D Iso-parametric elements in plane elasticity problem.

Unit V **(6 Hrs.)**

Formulation of stiffness matrix, analysis of spring assemblage, member approach for truss and beam element, node numbering, assembly of element equations, formation of overall banded matrix equation, boundary conditions and solution for primary unknowns, applications to truss and beam not involving unknowns more than three.

Unit VI **(6 Hrs.)**

Formulation of stiffness matrix using member approach for portal frame and grid elements, transformation matrix, applications to frame and grid not involving unknowns more than three.

Termwork:

The Termwork shall be based on completion of assignments as given below.

1. At least one assignment on each unit.
2. One assignment based on FEM by using coding tools for
   a) Formulation of stiffness matrix for any 1-D element
   b) Formulation of stiffness matrix for any 2-D element
3. Finite Element Method -Software applications of any one of following cases using any standard available software.
   a) Truss/ grid problem
   b) Plane stress / plane strain problem

Reference Books

1. A first course in the finite element method-Daryl L. Logon, Thomson Publication.
2. Nonlinear finite element analysis by Reddy- Oxford University Press.
3. Introduction to the Finite Element Method – Desai & Abel, CBS Publishers & Distributors, Delhi
4. Introduction to Finite Elements in Engineering – T.R. Chandrupatla & A.D. Belegundu Prentice Hall of India Pvt. Ltd.
5. Matrix, Finite Element, Computer & Structural Analysis – M. Mukhopadhyay, Oxford IBH Publishing Co. Pvt. Ltd.
6. Finite Element Analysis – Theory & Programming – C.S. Krishnmoorthy, TATA McGraw Hill Publishing Co. Ltd.
7. An Introduction to the Finite Element Method – J.N. Reddy, TATA Mc Graw Hil Publishing Co. Ltd.
8. Theory & Problems – Finite Element Analysis – Gorge R. Buchanan, Schaum's Outline series. TATA Mc Graw Hill Publishing Co. Ltd.
9. The Finite Element Method – O.C. Zien kiewicz, TATA Mc Graw Hill Publishing Co. Ltd.
10. Finite Element Analysis – S.S. Bhavikatti, New Age International (P) Ltd.

401 0010 Elective III (6): Airport & Bridge Engineering

Teaching scheme
Lectures: 3 hours/week
Practical: 2 hrs

Examination Scheme
In-Sem Exam: 30 marks 1 hour
End-Sem Exam: 70 marks 2.5 hrs
Termwork: 50 marks

Unit 1: (6 hrs)

Introduction:

Advantages and limitations of air transportation. Aeroplane component parts and important technical terms, Organizations related to Air Transportation (ICAO, FAA, AAI) Roles and Responsibilities.

Airport planning:

Aircraft characteristics, which influence judicious and scientific planning of airports, Selection of sites, survey and drawings to be prepared for airport planning, Air Travel Demand forecasting, Airport classification by ICAO.

Unit 2: (6 hrs.)

Airport layout:

Characteristics of good layout, runway configuration, airport obstruction, location of terminal buildings, aprons and hangers. Zoning requirements regarding permissible heights of constructions and landing within the airport boundary, Airport landslide planning, Navigation and landing aids – ILS, Air Traffic Control (ATC).

Design of Runways and taxiways:

Runway orientation, wind coverage, use of wind rose diagram, basic runway length, corrections for elevation, temperature and gradient as per ICAO and FAA recommendation, Taxiways – Concept, types, design criteria.

Unit 3: (6 hrs.)

Structural Design of Runways and taxiways:

Runway pavement design criteria, aircraft loading, Design methods for flexible and rigid runways, Airport drainage.

Unit 4: **(6 hrs.)**

Heliports

Helicoptor characteristics, planning of heliports - site selection, size of landing area, orientation of landing area, Heliport marking and lighting, Vertical Takeoff and Landing (VTOL).

Unit 5: **(6 hrs.)**

Bridge engineering:

Introduction:

Classification of bridges, components of bridges, preliminary data to be collected during investigation of site for bridges, determination of discharge – empirical formula, direct methods, economical span, afflux, HFL, scour depth and clearance, locations of piers and abutments, factors influencing the choice of bridge super structure, approach roads.

Loads on bridges:

Brief specifications of different loads, forces, stresses coming on bridges, IRC load specification, requirements of traffic in the design of highway bridges.

Substructure:

Abutment, Piers, and wing walls with their types based on requirement and suitability.

Unit 6: **(6 hrs)**

Types of bridges

Various types of bridges:

Culvert: Definition, waterway of culvert and types.

Temporary bridges: Definition, materials used brief general ideas about timber, floating and pantoon bridges.

Movable Bridges: Bascule, cut boat, flying, swing, lift, transporter and transverse bridges, their requirement and suitability.

Fixed span bridges: Simple, continuous, cantilever, arch, suspension, bowstring girder type and rigid frame and cable stayed bridges, materials for super structure.

Bearing: Definition, purpose and importance. Types of bearings with their suitability.

Erection of bridge super structure and maintenance:

Introduction to different techniques of erection of bridge super structure and maintenance of bridges.

Term work:

Term work shall consist of: (Any eight)

1. Recent Trends in Airport planning and design (report expected)
2. Assignment on study and use of Windrose Type 1 and 2 diagram
3. Assignment on Runway Design for length and related corrections
4. Structural Design of Flexible or Rigid Runway
5. Selection of Bridge site, alignment and collection of design data
6. Assignment on conditional assessment of existing Bridges
7. Seminar on one topic each in Airport Engineering or Bridge Engineering
8. Report on Guest lecture in Airport Engineering or Bridge Engineering
9. Site visit to Bridge site or Airport site

Text Books:

1. Bridge engineering – S. Ponnuswamy, Tata Mc Graw – Hill publishing co. Ltd. New Delhi.
2. Airport planning and design – S.K. Khanna , M.G. Arora , S.S. Jain, Nem Chand and Brothers, Roorkee.
3. Airport Engineering - Rangawala, Charotar publishing House, Anand 388001 (Gujrat)
4. Essentials of Bridge Engineering – D. Johnson and Victor, Oxford and IBH publishing Co. Pvt. Ltd. , New Delhi.
5. Bridge engineering – Rangawala, Charotar Publishing House, Anand –388 001.
6. Principles and practice of Bridge Engineering – S.P. Bindra, Dhanpatrai and Sons, Delhi.

401 010 Elective IV (1): Construction Management

Teaching Scheme:
Lectures: 3 hours/week
Practical: 2 hours/week

Examination Scheme:
Theory Examination:
In-sem : 30 marks (1 Hour)
End-sem:70 marks (2.5.Hours)
Term work: 50 Mark

Unit – I **(6 Hrs.)**

Overview of construction sector:

Role of construction industry in infrastructure development, components of infrastructure sector, construction industry nature, characteristics, size, structure, role in economic development, construction management – necessity, applications, project management consultants – role, types, selection and appointment process, project overruns and means to combat them, project monitoring and reporting systems, managerial correspondence and communications, generation and identification of project investment opportunities. (*At least 2 expert lectures by experts from field are to be conducted on above topics).

Unit – II **(6 Hrs.)**

Construction scheduling, work study and work measurement Construction scheduling. Construction project scheduling – purpose, factors affecting scheduling, time as a control tool, work breakdown structure, project work breakdown levels, line of balance technique, repetitive project management Work study and work measurement .

Definition, objectives, basic procedure of work study, symbols, activity charts, string diagrams, time and motion studies.

Unit – III **(6 Hrs.)**

Labour laws and financial aspects of construction projects Labour laws. Need and importance of labour laws, study of some important labour laws associated with construction sector-workmans compensation act 1923, Building and other construction workers act 1996, child labour act, interstate migrant workers act Financial aspects of construction projects. Capital investments: importance and difficulties, means of finance, working capital requirements, project cash flow projections and statements, project balance sheet, profit loss account statements.

Unit – IV **(6 Hrs.)**

Elements of risk management and value engineering. Risk management. Introduction, principles, types, origin, risk control, use of mathematical models: sensitivity analysis, break even analysis, simulation analysis, decision tree analysis, risk identification, analysis and mitigation of project risks, role of insurance in risk management. Value engineering Meaning of value, value analysis, value engineering and value management, energy resources, consumption patterns, energy cost escalation and its impact.

Unit – V **(6 Hrs.)**

Materials management and human resource management . Materials management Materials flow system, role of materials management in construction management and its linkage with other functional areas, vendor networking, buyer-seller relationships, eoq model and its variations, material codification and classification, concept of logistics and supply chain management, role of ERP in materials management – material resource information systems Human resource management. Human Resource in Construction Sector, Staffing policy and patterns, Human Resource Management Process, Human Resource Development Process, Performance Appraisal and Job Evaluation, Training and Career planning, Role of ERP in Human Resource Management – Human Resource Information System (HRIS).

Unit – VI **(6 Hrs.)**

Introduction to artificial intelligence technique. Basic terminologies and applications in civil engineering (a) Artificial neural network (b) Fuzzi logic (c) Genetic algorithm.

Term Work:

1. Site Visit to a Construction project to study following documents and preparing a report –

a. Project Cash Flow Analysis.

b. Project Balance Sheet.

c. Work Break Down Structure.

d. Materials Flow System in the Project.

2. Scheduling of a Construction Project using Line of Balance Technique.

3. Assignment on Work Study on any two Construction Trades.

4. Assignment on EOQ Model and its variation.

5. Assignment on application of AI techniques in Civil Engineering.

6. Seminar on any one topic from above syllabus.

Reference Books:

1. Projects – Planning, Analysis, Selection, Implementation and Review, Prasanna Chandra, Tata McGraw Hill Publications.
2. Construction Management and Planning – B. Sengupta and H. Guha, Tata McGraw Hill Publications.
3. Civil Engineering Project Management – C. Alan Twort and J. Gordon Rees, Elsevier Publications.
4. Total Project Management – The Indian Context – P. K. Joy, MacMillian Publications.
5. Materials Management–Gopalkrishnan & Sunderasan,Prentice Hall Publications.
6. Human Resource Management – Biswajeet Pattanayak, Prentice Hall Publishers.
7. Laws for Engineers : Dr. Vandana Bhat and PriyankaVyas –Published by PROCARE,5/B,/Sagarika Society,Juhu Tara Road,Juhu,Santacruz(W),Mumbai-400049 (procure@technolegal.org).
8. Labour and Industrial Laws – S. N. Mishra, Central Law Publications.
9. Artificial Neural Network – Veganarayanan – Prentice Hall.
10. Genetic Algorithm – David & Goldberg.
11. Fuzzi Logic & Engg Applications – Ross.
12. Principles of Construction Management by Roy Pilcher (McGraw Hill)

e-Resourses:

1. ERP Software-Builders Management Software.
2. Project mates Construction Software.

401 0010 Elective IV (2): Advanced Transportation Engineering

Teaching scheme	**Examination Scheme**
Lectures: 3 hours/week	**In-Sem Exam: 30 marks 1 hour**
Practical: 2 hrs	**End-Sem Exam: 70 marks 2.5 hrs**
	Termwork: 50 marks

Unit I **(6 hrs.)**

Transport System Planning: Transportation planning process and types of surveys. Travel demand forecasting - trip generation, modal spilt analysis, trip distribution and route assignment analysis, Transportation System Management (TSM), application in Comprehensive Mobility Plan (CMP) and DPR.

Unit II **(6 hrs.)**

Urban Transport Technology: Classification- light, medium, mass and rapid transit system, Introduction to Intelligent Transportation System (ITS) and its components, Public Transport Policy. Introduction to BRT, Mono rail, Metro rail, Bullet train and Hyperloop. Concept of Integrated Inter Model Transit System and freight transportation.

Unit III **(6 hrs.)**

A. Transport Economics & Financing: Road user cost **-** Vehicle operations cost, running cost, value of travel time, road damage cost, accident cost. Economic evaluation – Benefit cost method, Net present value method, First year rate of return method, Internal rate of return method & comparison of various methods.

B. Environmental Impact Assessment: EIA requirement of highway projects, procedure and guidelines, pollution cost and concept of congestion pricing.

Unit IV **(6 hrs.)**

Traffic Engineering: Traffic studies, basic traffic theory, traffic analysis process, level of service, intersection studies- turning movements, grade separated intersection, signal design- IRC method and Webster’s method, parking study and analysis, bicycle and pedestrian facility design, instrumentation of traffic monitoring.

Unit V **(6 hrs.)**

Study of flexible pavement: Philosophy of design and design criteria, design of flexible pavement using IRC 37-2012, Distresses in flexible pavement, evaluation of pavement – Benkelmen beam, Falling Weight Deflectometer (FWD), Pavement Management Systems (PMS).

Unit VI **(6 hrs.)**

a) **Study of rigid pavement:** Philosophy of rigid pavement, comparison of rigid pavement over flexible pavement, types of rigid pavements, design of rigid pavement using IRC 58-2015 including design of joints, distresses in rigid pavement.

b) **Overlay types and their design as per IRC:** Types of overlays, design of overlay using IRC 81-1997.

Term work:

1. Traffic counts using Manual Methods.
2. Design of a flexible pavement using IRC: 37-2012 using IITPAVE.
3. Design of rigid pavement using IRC: 58-2015.
4. Road deflections measurement using Benkelmen Beam method.
5. Design of an overlay using IRC: 81-1997.
6. Conduct of distress surveys on a flexible pavement or a rigid pavement and determining its condition index (PCI).
7. Study of any two softwares related to transportation engineering.
8. Study of format of household survey and recording sample measurements.
9. Parking survey and analysis.

Reference Books:

1. Highway Engineering - Laurence I Hewes & Clarkson H Oglesby
2. Traffic Engineering and Transport Planning - L R Kadiyali, Khanna Publishers.
3. The Design and Performance of Road Pavements - David Croney, Paul Croney.
4. Understanding Traffic System -Michel A Taylor, William Young, PeterW Bonsall.
5. Principles of Urban Transport Systems Planning - B. G.Hutchinson.
6. Introduction to transport planning - M. J. Bruton.

7. Transportation Engineering An Introduction – C. Jotin Khisty, B. Kent Lall, Pearson Publication.
8. Transportation Engineering & Planning – C. S. Papacostas, P. D. Prevedouros, Pearson Publication.
9. Principles of Pavement Design - E.F. Yoder (John Wiley & Sons, lnc USA).
10. Fundamentals of Transportation Engineering - C. S. Papacostas.
11. Pavement analysis and Design – Huang Y H, Prentice Hall, Englewood Cliff, New Jersey.
12. Introduction to Transportation Engg. and Planning – Morlok E K, McGraw-Hill company.
13. Fundamentals of Traffic flow Theory – Drew, McGraw-Hill book Co.
14. A course in Traffic Planning and design-Saxena Subhash,Dhanpat Rai & sons,Delhi
15. Traffic analysis (New technologies new solutions)-Taylor M P ,Hargreen Pub.Co. New Delhi.

Codes:

1. IRC 37-2012
2. IRC 58-2015
3. IRC 81-1997
4. IRC 82-2015
5. IRC 115-2014

Hand Books:

Handbook of Road Technology _Lay M. G.Gorden Breach Science Pub.Newyork.

e-Resources:

1) www.nptel.iitm.ac.in/courses/iitkanpur
2) www.cdeep.iitb.ac.in/nptel

401 010 Elective IV (3): Advanced Foundation Engineering

Teaching Scheme
Lectures: 3 Hours/week
Practical: 2 Hours/week

Examination Scheme
Theory Examination:
In-sem : 30 marks (1 Hr.)
End-sem:70 marks (2.5Hrs.)
Term work: 50 Mark

Unit I **(6 Hrs.)**

IS code provision in respect of subsoil exploration for dams, canals, tunnels, off shore structure, air ports and bridges. IRC, provisions for exploration in respect of roads. Case studies of failures of foundation.

Unit II **(6 Hrs.)**

Design of pile based on cyclic load test. Study of provision made in different IS codes related to deep foundation, various types of pile. Design of Racer piles & piles subjected to lateral load. Testing and Design of piles subjected to tensile loads.

Unit III **(6 Hrs.)**

Design of under reamed pile foundation subjected to tensile loads. Design of sand drains and stone columns.

Unit IV **(6 Hrs.)**

Design of shallow foundations subjected to inclined loads. Design of Raft foundation on different types of soil. Design of combined and isolated footing based on field test including calculation of settlement. Introduction to software available for geotechnical foundation design.

Unit V **(6 Hrs.)**

Study of various provisions made as per IRC and as per IS in respect of design of well foundation. Case studies of failure of well foundation. Design of Rock fill coffer Dams.

Unit VI **(6 Hrs.)**

Stress distribution in the shaft, tunnels, underground conduits, classification, load on ditch conduits, positive and negative projecting conduits, and Imperfect ditch conduits.

Term Work:

Term work will consist of

A) Any Four of following 6 assignments.

1) Comparative study of provisions made for the extent of exploration in IS, IRC codes adapted by Indian railways, and PWD.
2) Detailed study of any two Geophysical methods of exploration.
3) Computations of Bearing capacity and Settlement of a Shallow Foundation involving inclined loads.
4) Design of Pile foundations subjected to inclined load and tensile load.
5) Design of Sand Drains.
6) Comparative study of provisions for well Foundation as per IS, IRC and code adapted by Indian railways.

B) Computer Modeling:

Design of any one type of Deep foundation using computer software.

C) Site visit and Case study:

1) One site visit to any important deep foundation and submission of report on the same giving details of design and construction.
2) Any one case study of failure of foundation from the published literature.

Reference Books:

1. Foundation Analysis and Design- Joseph E. Bowels, TATA Mc-Graw hill.
2. Design Aids in Soil Mechanics and Foundation Engineerimg-Shenbage R Kaniraj, TATA Mc-Grawhill.
3. Foundation Design & Construction (4th Ed.)- M.J.Tamlinson, ELBS publication.
4. G. A. Leonards, Foundation Engineering, McGraw-Hill, 1962.
5. R.B. Peck, W.E. Hanson and T.H. Thornburn, Foundation Engineering, 2nd Edition, John Wiley and Sons, 1974.
6. "Principles of Foundation Engineering" by B.M. Das.
7. Theory and Practice of Pile Foundations Wei Dong Guo CRC Press.

I.S .Codes:

IS: 1892-1979 – "Code of Practice for Subsurface Investigation for Foundation".

IS: 2131-1981 (Reaffiemed 1997), "Method for Standard penetration Test for Soils".

IS: 6403-1981 – “Code of Practice for Determination of B.C. of Shallow Foundation”.

IS: 8009 (Part-1) 1976, “Code of Practice for Calculation of settlements of foundations”.

IS: 1904-1986, “Code of Practice for Design and Construction of Foundations in Soils, general Requirements”.

IS: 2911-1979, “Code of Practice for Design and Construction of Pile Foundation”.

Handbooks:

1. Fang , H.Y.,(1991),” Foundation Engineering Handbook”, Chapman & Hall, NY.
2. Teng .W.C.(1962), Foundation Design , Prentice Hall International.
3. Foundation Design Manual by Narayan V. Nayak, Dhanpat Rai & Sons.

401 0010 Elective IV (4): Coastal Engineering

Teaching Scheme
Lectures: 3 Hours/week
Practical: 2 Hours/week

Examination Scheme
Theory Examination:
In-sem: 30 marks (1 Hour)
End-sem: 70 marks (2.5.Hours)
Termwork : 50 marks

Unit I **(6 Hrs.)**
Basics of Ocean Waves:
Generation ,classification, Basic understanding of wave mechanics including wave propagation,wave theories,, wave diffraction , wave refection, wave breaking. Waves of unusal character-currents, giant waves , tsunami etc.

Unit II **(6 Hrs.)**
Tides:
Tide producing forces- earth moon and earth sun system , dynamic theory of tides-; types of tides- tides and tidal current in shallow sea, storm surges, tides in rivers and estuaries ,tidal power.

Unit III **(6 Hrs.)**
Coastal Processes:
Coastal process- Erosion/accretion due to waves, bed forms, long shore transport (Littoral drift) estimate of wave induced sediment, budget. Tides, effect of Tides, stability of inlets. Effect of construction of coastal structures on stability of shoreline / beaches.

Unit IV **(6 Hrs.)**
Design of Marine Structures:
Design of Marine Structures: Seawalls, Revetments, Breakwater rubble mound, composite, floating and pneumatic types, and jetties. Offshore structures, Oil Production platform, sub marine pipelines. Model studies.

Unit V **(6 Hrs.)**
Design Technology:
Dredging Technology: Types of dredgers, design of disposal methods of dredged materials
Environmental aspect of dredging , studies for feasibility of dumping ground for dredged material.

Unit-VI **(6 Hrs.)**
Coastal Management:
Pollution in Coastal zone, disposal of waste/dredged spoils, design criteria of coastal outfall inlets and system. Oil spills and contaminants, coastal zone management: activities in coastal zone, CRZ, Issues related to Integrated coastal zone management. Coastal regulation zone.

Reference Books:

1. Brunn Per ,B. U. Naik, "Shore Protection Manual", NIO Goa.
2. Quinn A. D., "Port Planning", Mc Grow Hill Book Co. New York.
3. Richard Silvester, "Coastal Engineering", Vol-I-II, University of Western Australia.
4. Shore Protection Manual-U.S.Waterways Experiment Station Corps of Engineer.
5. Costal Engineering Research Center, Vickburg andU.S.A.1984.Coastal Protection Manual 2002.
6. Harbour and Coastal Engineering", Vol. I&II, Ocean and Coastal Engineering Publication, NIOT, Chennai.

Term work-
One assignment on each unit.

401 010 Elective IV: Open Elective : 5 (a): Plumbing Engineering

Teaching Scheme:
Lectures: 3 hours/week
Practical: 2 hours/week

Theory Examination Scheme:
In-sem : 30 marks (1 Hour)
End-sem :70 marks (2.5 Hours)
Term work: 50 Marks

Unit I (6Hrs.)

Introduction to plumbing engineering Definition- plumbing engineering/public health engineering, Indian plumbing industry, Roles of plumbing contractor, plumber, plumbing consultant, plumbing terminology, Principles of plumbing,

a) **Introduction to codes and standards:**
Introduction to UPC-I and ITM, Green plumbing code supplement-India (GPCS-I) and other codes applicable in plumbing, Approvals of authority having jurisdiction, General regulations, Testing and labeling, Alternative materials, workmanship and minimum standards, Prohibited fittings and practices, Local laws related to plumbing.

b) **Architectural and structural coordination**, plumbing shafts, Sunken toilet floors, Ledge walls.

Unit II (6 Hrs)

Water Supply, fixtures and fittings.

a) Water Supply**:** Types of water supply pipes Fittings and joints, Galvanized iron, Copper, Stainless steel, HDPE, MDPE, Rigid PVC, CPVC, PPR, Composite pipes, (PE-AL-PE), PEX, Joints, Jointing methods and materials, Tools etc. Water hammering, Pipe protection, Velocity, pressure, temperature limitations, Water Supply Fixture Unit (WSFU), Sizing, testing, Valves and regulators, Backflow prevention, Commissioning, Water tanks.

b) Plumbing fixtures, Water conserving fixtures, Rating system for water efficient products, (WEP-I), Water closets, Bidets, Urinals, Flushing devices, Lavatory and bath units, Kitchen sinks, Water coolers, Purifiers, Drinking water fountain, Cloth washers, Mop sinks, Dish washers, Receptors Overflows, Strainers, Standard heights. Prohibited fixtures, Floor slopes, Minimum spacing.

Unit III **(6Hrs.)**

Sanitary system and Storm water Drainage:

a) Sanitary system: Fixtures, Appliances and appurtenance, Classification of fixtures, Soil and waste and grey water, Soil fixtures, Bathroom fixtures, Accessories, Indirect waste connections, Food handling establishments, Fixtures below invert level.

b) Building Drains:

Introduction, Four systems of plumbing, One pipe and two pipe system, Air admittance valves and solvents, Comparison of systems, Vent pipe, Symphonic action, Antisyphon and vent pipes, Loop, Circuits, Types of building drainage pipes, Fittings and jointing methods, Clean outs, Drainage fixture units (DFU), Sizing, Testing, Case study

Unit IV Traps and Interceptors **(6Hrs.)**

Traps-Purpose, Fixture traps and floor traps, Prohibited traps, Trap arm, Developed length, Trap seal, Trap seal protection, Venting of traps, Trap primers, Building traps, Clarifiers, Grease interceptors, Sizing, oil and sand interceptors.

b) Vents:

Vent requirement, Parts of vent system. Parts of vent system, Materials, Sizing, Vent connections, Flood rim level, Island sink venting, Venting of interceptors, Water curtain and hydraulic jump, Termination of vent stacks, Stack venting, Yoke vent, Wet venting.

Unit V **(6Hrs.)**

a) Building Sewers:

DFU, Change in direction of flow, Hydraulic jump,Sudsing stack, Cleanouts, Pipe grading, pipes and fittings suitable for building sewers, RCC, PVC, Nu-Drain, Stoneware., Sizing, testing, Types of traps, Gully, Chambers and manholes, Materials, Venting, Sizing, Testing, Sumps, Pumps, Sewage disposal, Septic tanks.

b) Plumbing in high rise buildings:

Definition of high rise building, Multiple storage tanks, Plumbing shafts, Break pressure tanks, Water supply, Hydro pneumatic system, Pressure reducing valves, Building drainage system, Rain water system, Sizing, Testing, Case study, Introduction to centralized hot water supply, Principles of design.

Unit VI **(6 Hrs)**

Design Parameters & Case Study

Introduction, Plumbing Drawings & Layouts, Water Supply Design Consideration, Sewer Network design consideration, Storm water design consideration as per CPHEEO manuals, Case study on each.

Term work

Term work will consist of 8 assignments with necessary plans /sketches.

1. Introduction of available codes in plumbing
2. Introduction of associations in plumbing in India and outside India
3. Detailed hydraulic design for High rise structure OR G+1 Bungalow by using software.
4. Compilation of rules and regulations of local governing bodies.
5. Roles of plumbing contractor and plumbing consultants.
6. Report on Plumbing fixtures and fittings and explain any ten.
7. Report on materials for water supply and drainage.
8. Report on necessity of traps, intercepts and vents

Books:

1. "Plumbing Engineering" by Deolalikar.
2. "Plumbing, Sanitation and Domestic Engineering" Volume – 1to 4 by G. S. Williams, Mc Graw Hill.
3. "Plumbing, Sanitation and Domestic Engineering, Data Sheets & Wall Charts" by G. S. Williams, Mc Graw Hill
4. "Plumbing Engineering, Theory and Practice" by Subhsh Patil. SEEMA Publishers Mumbai
5. "National Plumbing Codes Handbook", by R. Dodge Woodson.
6. "Central Public Health and Environmental Engineering Organisation Manual (CPHEEO)".

Codes:

1. Uniform Plumbing Code- India (UPC-I), 2008
2. Illustrated Training Manual (ITM), 2008.

401 010 Elective IV: Open Elective: 5 (b): Green Building Technology

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hours/week	**Theory Examination:**
Practical: 2 Hours/week	**In-sem : 30 Marks (1 Hour)**
	End-sem:70 Marks (2.5 Hours)
	Term work: 50 Marks

Unit I: (6 Hrs.)

Materials and Its Applicability, Indoor Environmental Quality, Reuse and Recycle of Construction Waste.

A) Eco Friendly/ Green Building Materials: To understand Environmental impact of building materials. Eco Friendly building materials, their composition, availability, production, physical properties etc. Application of the Eco Friendly/ Green Building materials for different components of the buildings at different level, both internally and externally.

B) Indoor environmental quality, Low VOC materials: Adhesives - Sealants, Paints- Coatings etc.

C) Construction Waste as a Resource- Resource Economics, Disposable Materials, Recovery, Recycling, Collection, Processing, Governmental Role in Waste Management, Potential for Reuse.

Unit II (6 Hrs.)

Site / Building Planning

A) Sustainable Site planning: wind / sun path, water management , material use, landscape, topography.

B) Climate Responsive Architecture: orientation, solar- wind, Building envelope.

C) Thermal comfort indices. Heat flow through building materials. Thermal properties of common building materials available in India. Thermal performance of building envelope. Air movement and buildings. Ventilation and buildings. Wind an Stack effect. Mechanical ventilation. HVAC System, Day lighting. Passive and sustainable architecture. Passive and active systems.

Unit III (6 Hrs.)

Embodied Energy, Life Cycle Assessment, Environmental Impact Assessment, Energy Audit and Energy Management.

A) Embodied energy of various construction materials. Introduction to the Concept: "Life Cycle assessment of materials".
B) EIA : Introduction to EIA., Process of EIA and its application through a case study., EIA as a strategic tool for sustainable development.
C) Energy Management.

Unit IV **(6 Hrs.)**

Appropriate Technologies / Approaches for:

A) Water conservation / efficiency.
B) Sanitation (Grey water, black water management, SWM)
C) Treatments.
D) Biogas.
E) Composting.
F) Solar energy and its applicability through panels, photovoltaic cells etc.
G) Use of "LED, CFL, Fresnel Lens" etc.
H) Wind energy and its use.
I) Orientation aspects in site planning to achieve maximum daylight and natural ventilation.

UNIT V: **(6 Hrs.)**

A) Clean Development Mechanism.
B) Kyoto Protocol.
C) Energy Conservation Building Code.

UNIT VI **(6 Hrs.)**

Rating Systems: - Leadership in Energy and Environmental Design (LEED), Green Globes, National Association for Home Builders (NAHB) – For Homes, Building Research Establishment Environmental Assessment Method (BREEAM), Green Star by Green Building Council Australia (GBCA), LEED India, Comprehensive Assessment System for Built Environment Efficiency (CASBEE), Estimada -Abu Dhabi Urban Planning Council (UPC) etc.

Term Work:

Any Eight of the following:

A) To study: Innovative Materials Developed by CBRI, SERC.
B) To study: Environmental Audit of any existing building and prepare a report.
C) To study, analyze present scenario of organic waste collection and management of any of the premise; preferably hotels.

D) To compare the benefits under different rating systems.

E) To prepare detailed plan for a hypothetical site indicating utility of solar path, wind direction, rainfall intensity etc. to make it sustainable.

F) To prepare a report on carbon credit.

G) To prepare a report on energy efficient buildings in India.

H) To study sustainable planning aspects for urban housing.

I) Study of Design of On Site Sanitation Systems for Indian conditions developed by Appasaheb Patwardhan Safai V Paryavaran Tantraniketan, Dehugaon .

J) To study the benefits given by Municipal Corporations to Green Buildings.

Reference Books and Additional Reading material:

1. Manual of Tropical housing and climate by Koenisberger.
2. Climate responsive architecture by Arvind Krishnan.
3. Manual of solar passive architecture - by Nayak J.K. R. Hazra J. Prajapati.
4. Energy Efficient Buildings in India by Milli Mujumdar.
5. Green Building Materials by Ross Spiegel and Dru Meadows.
6. Publications from - CBRI – Roorkee, - IDC – Mumbai, NID – Ahmedabad.
7. Solar Energy in Architecture and Urban Planning by Herzog Thomas.
8. Solar Heating, Design Process by Kreider Jan F.
9. Energy - Manual for college teachers (CEE publications).
10. Renewable Energy & Environment - A policy analysis for India (CEE publications).
11. Sustainable Building Design Manual-Volume I and II –TERI Publication.
12. Mechanical and Electrical Systems in Construction and Architecture-by Frank R Dagostino.

Principles of Air conditioning-By V. Paul Lang:

1. Heating, Cooling and lighting design methods for architecture. By Lechor Worbert.
2. LEED Manual.
3. Green Globes Manual.
4. Florida Green Building Coalition Manual.
5. The green building process.
6. Green building codes and standards.
7. International Green Construction Code.
8. ASHRAE 189P.
9. ANSI/GG 01, TERI, BREEAM etc.

401 010 Elective IV: Open Elective: 5 (c): Ferrocement Technology

Teaching Scheme:
Lectures: 3 hours/week
Practical: 2 hours/week

Examination Scheme:
Theory Examination:
In-sem : 30 marks (1 Hour)
End-sem:70 marks (2.5 Hours)
Term work: 50 Mark

Unit 1 **(6 Hrs.)**

What is Ferrocement?

a) Definition, Basic concept like bond increase. Comparison with concretes like RCC, Prestressed, Asbestos cement, Fiber reinforced, Polymer concretes. Composition of ferrocement. Special types of ferrocement. Ferrocement as substitute for conventional building materials. Typical characteristics and their applications.

b) Raw materials, skills, tools and plants. Ferrocement as material of construction. Forming a ferrocement structure. Properties and specifications of raw materials. Proportioning of cement mortar. Job requirements of required skills. Tools and plants.

Unit 2 **(6 Hrs.)**

Mechanical properties and construction methods:

a) Mechanical properties and typical features affecting design. Properties under static and dynamic loading. Shrinkage and creep. Testing of ferrocement.

b) Methods of constructing ferrocement structures. Standardizing method of construction. Planning the work. Fabricating skeleton, tying meshes and mortaring. Curing. Maintenance. Protective surface treatments. Damage to ferrocement structures.

Unit 3 **(6 Hrs.)**

Strength through shape and design:

a) Strength through shape. Design of structure based on form and shape. Forms in nature, various structural forma and their behavior. Typical strengths of different materials. Comparative study of various forms.

b) Design of ferrocement structures. Design, analysis and optimization. Special design considerations for ferrocement. Typical features of ferrocement affecting design. Conventional design methods like working stress, load factor, applied to ferrocement. Design based on equivalent area method for compression, tension and flexural members. Specific surface method and crack control method, Design of structures subjected to membrane stresses. Design of shaped structures in ferrocement like stiffened plates, arch faced walls, stiffened cavity walls and hollow floors and beams, Design of forms like ‘T’ ‘U’ ‘T’ ‘+’ ‘L’

Unit 4 **(6 Hrs.)**

Cost analysis and ferrocement in Building construction.

a) Cost analysis : Factors governing cost analysis. Special considerations for ferrocement structures. Cost comparison with conventional construction. Specifications for ferrocement structures. Quantity analysis of material and labour for ferrocement items. Cost and value of ferrocement construction.

b) Ferrocement in building construction. Ferrocement in foundations, walls, floors roofs. Ferrocement single wall construction. Design and construction of houses with cavity walls, hollow floors and hollow beams. Staircases and other building accessories. Earthquake resisting structures. Special characteristics of ferrocement to resist shock loading design and construction of quake proof structures.

Unit 5 **(6 Hrs.)**

Hydraulic and soil retaining structures in ferrocement :

a) Hydraulic structures. Why ferrocement? Water retaining structures, Storage tanks of various types. Structures across streams. Ferrocement in layered form used for lining, water proofing and surface coating.

b) Soil retaining structures. Types of retaining walls and their comparison with ferrocement arch faced wall. Design and method of fabrication and casting. Ferrocement counterfort retaining wall. Ferrocement containers for storing granular materials.

Unit 6 **(6 Hrs.)**

Space structures and precast products:

a) Ferrocement large size special purpose structures. Space structures like shells, pyramids, domes corrugated catenaries.

b) Precast ferrocement products : Why ferrocement for precasting? Methods of precasting. Design of precast elements. Ferrocement precast walling and flooring panels. Joints in precast ferrocement elements.

Term Work :

Minimum 02 site visits with detailed reports and one assignment based on each unit (Journal consisting of total 6 assignments + 2 visit reports).

Books Recommended:

1) Ferrocrete Technology- A Construction Manual. -- Dr. B. N. Divekar Published by the Author.

2) Ferrocement --- : B. R. Paul and R. P. Pama.Published by International Ferrocement Information Centre. A.I.T. Bangkok, Thailand.

3) Ferrocement and laminated cementitious composites --: A.E. Naaman. Publisher : Techno-press, Ann Arbor, Michigan, USA.

4) Ferrocement - Materials and applications; Publication SP 61, A C I Detroit. USA

5) State of the art report and guide for design, Construction and repairs of Ferrocement; ACI Committee Report. No. ACI 549R-88 and ACI 549.1R.88. Published by American Concrete Institute, Detroit, USA.

6) Chapter 1 titled 'Ferrocement' by S. P. Shah and P. N. Balaguru in book 'Concrete Technology and Design Vol. II, Editor; R. N. Swamy.

7) Proceedings of International Symposiums on 'Ferrocement and thin reinforced composites – Ferro 1 to Ferro 10. Available with International Ferrocement Information Centre, A I T Bangkok, Thailand.

8) Ferrocement Conference Proceedings of Ferrocement Society, India--FS 2011, F.S.2013, F. S. 2015.

401 010 Elective IV: Open Elective: 5 (d): Sub Sea Engineering

Teaching Scheme
Lectures: 3 hours/week
Practical 2 hours/week

Examination Scheme
Theory Examination
In-sem: 30 marks (1 Hour)
End-sem: 70 marks (2.5.Hours)
Termwork: 50 Marks.

Unit1 (6 Hrs.)

Introduction to oil and gas industry: general view of oil and gas industry, technological challenges and future developments. Overview of deep water developments: introduction, deep water areas and potential, challenges, route for development Metaocean and environmental conditions: Overview of the determination of Metaocean conditions (meteorological and oceanographic) and the influence of wave, wind, tide and current on marine operations. Introduction to marine ecology and its impact on marine operations.

Unit 2 (6 Hrs.)

Introduction to subsea infrastructure development: Summarize the current state of the art and highlights the design challenges. Outlines the way in which water depth influences the architecture and technology of Oil and Gas infrastructure.

Flow assurance: overview of flow assurance and the fundamentals of flow management for subsea production systems, Introduction to flow assurance issues like paraffin deposition; hydrate formation and blockage; Asphaltene precipitation; emulsions; experimental methods, flow assurance assessment methods; prevention, mitigation and remediation tools for flow assurance issues; thermal management and insulation materials.

Unit 3 (6 Hrs.)

Subsea installation and intervention: Overview of the installation of subsea plant, risers and pipelines and the main intervention methods including AUVs, ROVs and divers.

Subsea operations and control: An overview of the principle methods of subsea control including electrical, acoustic and hydraulic systems.

Subsea processing and artificial lift: introduction the analytical and numerical models used to design subsea processing systems for sustained recovery of hydrocarbons.

Unit 4 **(6 Hrs.)**

Reliability and integrity management: Introduction to Risk Assessment, FMECA and HAZOPS, Monitoring, Intervention and Inspection Methods, Data Management Construction management of oil field, future challenges.

Unit 5 **(6 Hrs.)**

Subsea field equipment, structures and architectures: scale of operations, environmental factors, A description of each of the pieces of the subsea infrastructure, their use and interconnection including subsea trees, flow lines, umbilicals, risers, moorings and pipelines Materials and corrosion. Types of corrosion found in the oilfield with emphasis on the effects of acid gases (CO_2 and H_2S).

Unit 6 **(6 Hrs.)**

Pipelines and design: Introduction to pipeline engineering, the main pipeline design challenge in deep water. Analysis and design methods of pipelines that address stress analysis, buckling and collapse of deep water pipelines. Limit state based strength design methods. Geotechnical aspects of pipeline design and its installation.

Deepwater risers: different design options available for deep water risers, and defines the key design drivers for each. General principles of stress analysis: An introduction to the principles of stress analysis and the principles of reliability based design, finite element analysis.

Termwork:--Shall consist of one assignment per unit.

References:

1. A Primer of Offshore Operations by Petex
2. Subsea Engineering Handbook Hardcover by Yong Bai (Editor), Qiang Bai (Editor)
C. Norsok standard Common requirements Subsea structures and piping system U-cr-001 Rev. 1, January 1995.
D. Norsok codes, DNV codes : Design specifications for subsea system.

401 010 Elective IV : Open Elective : 5 (e): (Geoinformatics)

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
Paper In-sem. 30 Marks (1 Hrs),
Paper End-sem : 70 Marks (2.5 Hrs.)

Unit I **(6 Hrs.)**

Introduction to Remote Sensing GIS and SBPS:

Electro-magnetic radiations **(**EMR) - atmospheric scattering, Raleigh scattering, Mie scattering, non-selective scattering -atmospheric absorption - atmospheric windows, refraction - interaction of EMR earth‘s surface - reflection - transmission - spectral signature - Reflectance characteristics of Earth‘s cover type: Vegetation, water, soil

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements. Introduction to SBPS, Segments and errors in GPS.

Unit II **(6 Hrs.)**

THERMAL REMOTE SENSING: Thermal radiation principles – Thermal interaction sensors and characters – thermal image characters – image degradation sources & correction – interpretation of thermal images – Application and Case studies.

MICROWAVE REMOTE SENSING: Introduction-Plane waves-Interference, Radar remote sensing - Radar basics- Antenna Systems -Real aperture radar - Radar frequency bands - SLAR Imaging Geometry, Resolution Concepts - Geometric Distortions, SAR – Concepts - Doppler principle & Processing. RADAR Interaction with earth surface- RADAR equation.

Unit III Unit II **(6 Hrs.)**

DIGITAL IMAGE PROCESSING :

Fundamentals of Image Processing, sensors model and pre processing, image enhancement, image classification, object recognition.

Unit IV **(6 Hrs.)**

OPEN SOURCE GIS:

DESKTOP GIS WITH OPEN SOURCE GIS : View Graphics – Data exchanges- portability and interoperability – Raster handling and Image analysis – vector data management –Rater and vector analysis - 2D/3D vectors with topology, 3D Voxel, 2D Raster.

OPEN SOFTWARE AND WEB MAPPING : Open Source Software : GRASS, QGIS, OSSIM, PostopesSQL and (R) Environment – WEB Mapping Architecture and components – WEB mapping servers- Thin clients in WEB mapping - WMS,WFS, WCS,WPS and other web services- Open Server standards.

Unit V **(6 Hrs.)**

MAP PROJECTION:

Concepts of sphere, ellipsoid and geoid - latitudes, longitudes and graticules –map projections– shape, distance, area and direction properties - role of aspect, development surface, secant and light source / view points – perspective and mathematical projections – Indian maps and projections – Map co-ordinate systems – UTM and UPS references – common projections and selections– projections for hemispheres and the world maps , Map projection for cadastral maps.

Unit VI **(6 Hrs.)**

FUNDAMENTALS and GEOMETRIC GEODESY:

Definitions- Classifications, Problem of Geodesy and purpose of Geodesy Historical development and Organization of Geodesy. Reference Surfaces and their relationship. Applications, Engineering, Lunar, Planetary and interferometric Synthetic aperture radar Geodesy – Local and International Spheroid.

Geomentry of ellipsoid, fundamental mathematical relationship of ellipsoid, Geodetic, Geocentric and Reduced latitudes and their relationship. Ellipsoidal Co-ordinates in terms of Reduced, Geodetic and geocentric latitude. Radius of curvature in the meridian & prime vertical and their relationship. Mean Radius of curvature in any azimuth, Length of the meridian arcs and arcs of parallel and Area of trapezium on the ellipsoid. Curves on the ellipsoid, properties of Geodesic.

Reference Books:

1. Wolfgang Torge, Geodesy, Walter De Gruyter Inc., Berlin, 2001
2. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York, 2002.
3. Neteler M, Helena M (2008) ‗Open source GIS: A GRASS GIS approach', 3rd edn, Springer, New York
4. Kang-Tsung Chang, Introduction to Geographic Information Systems, Mc-Graw Hill Publishing, 2nd Edition, 2011.
5. John, R. Jensen, Introductory Digital Image Processing, Prentice Hall, New Jersey,2005 3rd edition
6. R.W. Anson and F.J. Ormeling, Basic Cartography for students and Technicians. Vol.I, II and III, Elsevier Applied Science Publishers, 3rd Edition, 2004.

401006 Project work

Teaching Scheme:
Tutorial: 6 Hrs/week

Examination Scheme:
TW : 50 Marks.
Oral : 100 Marks.

Project Work will be evaluated for an individual student based on the presentation of the work done in a year(I Sem + II Sem) and submission of the report .The student may work in a group during project work, if any.

The project work shall consist of any one of the following nature in Civil Engineering related subjects.

1. Experimental investigation.
2. Software development.
3. Benefit : Cost economic analysis.
4. Case study with own design.
5. Working model design and fabrication.
6. Case study with development of methodology using soft computing tools.

The details of report writing and preparation of report will be similar to that of as mentioned in syllabus of Project Phase I in first semester.

Evaluation of Project work in final exam. Will be done by the pair of internal guide having minimum 3 years approved experience as teacher and external guide.

It is recommended to promote the students to present a paper based on project work in appropriate conference / journal.

Faculty of Engineering
Savitribai Phule Pune University, Pune

Maharashtra, India

Syllabus

for

Fourth Year of Computer Engineering
(2015 Course)

(with effect from 2018-19)

Prologue

It is with great pleasure and honor that I share the syllabi for Fourth Year of Computer Engineering (2015 Course) on behalf of Board of Studies (BoS), Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design at both UG and PG programs.

It is always the strenuous task to balance the syllabus with the blend of core subjects, current developments and exotic subjects. By considering all the aspects with adequate prudence the contents are designed to make the graduate competent enough as far as employability is concerned. It is absolutely necessary and justified to add sufficient flexibility in the given constraints leading the curriculum design near to perfection.

It may be highly subjective to include or exclude the courses, but benefit of the learner is always the nucleus the process. Many thoughts, suggestions, recommendations and directions help us to come up with the final contents. For the final year finishing touch is absolutely necessary which is provided with project based learning at the most.

I sincerely thank all the minds and hands who work adroitly to materialize these tasks. I really appreciate everyone’s contribution and suggestions in finalizing the contents.

Dr. Varsha H. Patil
Coordinator, Board of Studies (Computer Engineering), SPPU, Pune

[This document contents Program Educational Objectives - Program Outcomes - Program Specific Outcomes(page 3),Courses (teaching scheme, examination, marks and credit)(page 4-5), Courses syllabi(page 7-85) and FE to BE courses at a glance(Page 86-87)].

Other related Syllabus Links:
Syllabus for First Year Engineering (2015 Course)
Syllabus for Second Year Computer Engineering (2015 Course)
Syllabus for Third Year Computer Engineering (2015 Course)

Savitribai Phule Pune University, Pune
Bachelor of Computer Engineering

Program Educational Objectives

1. To prepare globally competent graduates having strong fundamentals, domain knowledge, updated with modern technology to provide the effective solutions for engineering problems.
2. To prepare the graduates to work as a committed professional with strong professional ethics and values, sense of responsibilities, understanding of legal, safety, health, societal, cultural and environmental issues.
3. To prepare committed and motivated graduates with research attitude, lifelong learning, investigative approach, and multidisciplinary thinking.
4. To prepare the graduates with strong managerial and communication skills to work effectively as individual as well as in teams.

Program Outcomes

Students are expected to know and be able –

1. To apply knowledge of mathematics, science, engineering fundamentals, problem solving skills, algorithmic analysis and mathematical modeling to the solution of complex engineering problems.
2. To analyze the problem by finding its domain and applying domain specific skills
3. To understand the design issues of the product/software and develop effective solutions with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4. To find solutions of complex problems by conducting investigations applying suitable techniques.
5. To adapt the usage of modern tools and recent software.
6. To contribute towards the society by understanding the impact of Engineering on global aspect.
7. To understand environment issues and design a sustainable system.
8. To understand and follow professional ethics.
9. To function effectively as an individual and as member or leader in diverse teams and interdisciplinary settings.
10. To demonstrate effective communication at various levels.
11. To apply the knowledge of Computer Engineering for development of projects, and its finance and management.
12. To keep in touch with current technologies and inculcate the practice of lifelong learning.

Program Specific Outcomes (PSO)

A graduate of the Computer Engineering Program will demonstrate-

PSO1: Professional Skills-The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying.

PSO2: Problem-Solving Skills- The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.

PSO3: Successful Career and Entrepreneurship- The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
(with effect from 2018-19)

Semester I

Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks						Credit	
		Theory	Practical	In-Sem	End-Sem	TW	PR	OR/ *PRE	Total	TH/ TUT	PR
410241	High Performance Computing	04	--	30	70	--	--	--	100	04	--
410242	Artificial Intelligence and Robotics	03	--	30	70	--	--	--	100	03	--
410243	Data Analytics	03	--	30	70	--	--	--	100	03	--
410244	Elective I	03	--	30	70	--	--	--	100	03	--
410245	Elective II	03	--	30	70	--	--	--	100	03	--
410246	Laboratory Practice I	--	04	--	--	50	50	--	100	--	02
410247	Laboratory Practice II	--	04	--	--	50	--	*50	100	--	02
410248	Project Work Stage I	--	02	--	--	--	--	*50	50	--	02
									Total Credit	**16**	**06**
Total		**16**	**10**	**150**	**350**	**100**	**50**	**100**	**750**	**22**	
410249	Audit Course 5									**Grade**	

Elective I	Elective II
410244 (A) Digital Signal Processing	**410245 (A)** Distributed Systems
410244 (B) Software Architecture and Design	**410245 (B)** Software Testing and Quality Assurance
410244 (C) Pervasive and Ubiquitous Computing	**410245 (C)** Operations Research
410244 (D) Data Mining and Warehousing	**410245 (D)** Mobile Communication

410249-Audit Course 5 (AC5) Options:

AC5-I Entrepreneurship Development

AC5-II: Botnet of Things

AC5-III: 3D Printing

AC5-IV: Industrial Safety and Environment Consciousness

AC5-V: Emotional Intelligence

AC5-VI: MOOC- Learn New Skills

Abbreviations:

TW: Term Work **TH:** Theory **OR:** Oral **PR:** Practical

Sem: Semester *__PRE__: Project/ Mini-Project Presentation

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
(with effect from 2018-19)

Semester II

Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks						Credit	
		Theory	Practical	In-Sem	End-Sem	TW	PR	OR/ *PRE	Total	TH/ TUT	PR
410250	Machine Learning	03	--	30	70	--	--	--	100	03	--
410251	Information and Cyber Security	03	--	30	70	--	--	--	100	03	--
410252	Elective III	03	--	30	70	--	--	--	100	03	--
410253	Elective IV	03	--	30	70	--	--	--	100	03	--
410254	Laboratory Practice III	--	04	--	--	50	50	--	100	--	02
410255	Laboratory Practice IV	--	04	--	--	50	--	*50	100	--	02
410256	Project Work Stage II	--	06	--	--	100	--	*50	150	--	06
									Total Credit	**12**	**10**
Total		**12**	**14**	**120**	**280**	**200**	**50**	**100**	**750**	**22**	
410257	Audit Course 6									**Grade**	

Elective III	**Elective IV**
410252 (A) Advanced Digital Signal Processing	**410253 (A)** Software Defined Networks
410252 (B) Compilers	**410253 (B)** Human Computer Interface
410252 (C) Embedded and Real Time Operating Systems	**410253 (C)** Cloud Computing
410252 (D) Soft Computing and Optimization Algorithms	**410253 (D)** Open Elective

410259-Audit Course 6 (AC6) Options:

AC6-I: Business Intelligence
AC6-II: Gamification
AC6-III: Quantum Computing
AC6-IV: Usability Engineering
AC6-V: Conversational Interfaces
AC6-VI: MOOC- Learn New Skills

Abbreviations:

TW: Term Work **TH:** Theory **OR:** Oral **PR:** Practical

Sem: Semester *__PRE__: Project/ Mini-Project Presentation

SEMESTER I

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410241: High Performance Computing

Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210253-Microprocessor, 210244- Computer Organization and Architecture, 210254-Principles of Programming Languages, 310251- Systems Programming and Operating System

Companion Course: 410246-Laboratory Practice I

Course Objectives:

- To study parallel computing hardware and programming models
- To be conversant with performance analysis and modeling of parallel programs
- To understand the options available to parallelize the programs
- To know the operating system requirements to qualify in handling the parallelization

Course Outcomes:

On completion of the course, student will be able to–

- Describe different parallel architectures, inter-connect networks, programming models
- Develop an efficient parallel algorithm to solve given problem
- Analyze and measure performance of modern parallel computing systems
- Build the logic to parallelize the programming task

Course Contents

Unit I	Introduction	09 Hours

Motivating Parallelism, Scope of Parallel Computing, Parallel Programming Platforms: Implicit Parallelism, Trends in Microprocessor and Architectures, Limitations of Memory, System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Scalable design principles, Architectures: N-wide superscalar architectures, Multi-core architecture.

Unit II	Parallel Programming	09 Hours

Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, The Age of Parallel Processing, the Rise of GPU Computing, A Brief History of GPUs, Early GPU.

Unit III	Basic Communication	09 Hours

Home

Operations- One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations.		
Unit IV	**Analytical Models of Parallel Programs**	**09 Hours**
Analytical Models: Sources of overhead in Parallel Programs, Performance Metrics for Parallel Systems, and The effect of Granularity on Performance, Scalability of Parallel Systems, Minimum execution time and minimum cost, optimal execution time. Dense Matrix Algorithms: Matrix-Vector Multiplication, Matrix-Matrix Multiplication.		
Unit V	**Parallel Algorithms- Sorting and Graph**	**09 Hours**
Issues in Sorting on Parallel Computers, Bubble Sort and its Variants, Parallelizing Quick sort, All-Pairs Shortest Paths, Algorithm for sparse graph, Parallel Depth-First Search, Parallel Best-First Search.		
Unit VI	**CUDA Architecture**	**09 Hours**
CUDA Architecture, Using the CUDA Architecture, Applications of CUDA Introduction to CUDA C-Write and launch CUDA C kernels, Manage GPU memory, Manage communication and synchronization, Parallel programming in CUDA- C.		

Books:

Text:

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", 2nd edition, Addison-Wesley, 2003, ISBN: 0-201-64865-2
2. Jason sanders, Edward Kandrot, “CUDA by Example”, Addison-Wesley, ISBN-13: 978-0-13-138768-3

References:

1. Kai Hwang, ”Scalable Parallel Computing”, McGraw Hill 1998, ISBN:0070317984
2. Shane Cook, “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs”, Morgan Kaufmann Publishers Inc. San Francisco, CA, USA 2013 ISBN: 9780124159884
3. David Culler Jaswinder Pal Singh, ”Parallel Computer Architecture: A Hardware/Software Approach”, Morgan Kaufmann,1999, ISBN 978-1-55860-343-1
4. Rod Stephens, “ Essential Algorithms”, Wiley, ISBN: 978-1-118-61210-1

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410242: Artificial Intelligence and Robotics

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210254-Principles of Programming Languages

Companion Course: 410246-Laboratory Practice I

Course Objectives:

- To understand the concept of Artificial Intelligence (AI)
- To learn various peculiar search strategies for AI
- To acquaint with the fundamentals of mobile robotics
- To develop a mind to solve real world problems unconventionally with optimality

Course Outcomes:

On completion of the course, student will be able to–

- Identify and apply suitable Intelligent agents for various AI applications
- Design smart system using different informed search / uninformed search or heuristic approaches.
- Identify knowledge associated and represent it by ontological engineering to plan a strategy to solve given problem.
- Apply the suitable algorithms to solve AI problems

Course Contents

Unit I	Introduction	08 Hours

Artificial Intelligence: Introduction, Typical Applications. State Space Search: Depth Bounded DFS, Depth First Iterative Deepening. Heuristic Search: Heuristic Functions, Best First Search, Hill Climbing, Variable Neighborhood Descent, Beam Search, Tabu Search. Optimal Search: A^* algorithm, Iterative Deepening A^*, Recursive Best First Search, Pruning the CLOSED and OPEN Lists.

Unit II	Problem Decomposition and Planning	08 Hours

Problem Decomposition: Goal Trees, Rule Based Systems, Rule Based Expert Systems. Planning: STRIPS, Forward and Backward State Space Planning, Goal Stack Planning, Plan Space Planning, A Unified Framework For Planning. Constraint Satisfaction : N-Queens, Constraint Propagation, Scene Labeling, Higher order and Directional Consistencies, Backtracking and Look ahead Strategies.

Unit III	Logic and Reasoning	08 Hours

Home

Knowledge Based Reasoning: Agents, Facets of Knowledge. Logic and Inferences: Formal Logic, Propositional and First Order Logic, Resolution in Propositional and First Order Logic, Deductive Retrieval, Backward Chaining, Second order Logic. Knowledge Representation: Conceptual Dependency, Frames, Semantic nets.

Unit IV	Natural Language Processing and ANN	08 Hours

Natural Language Processing: Introduction, Stages in natural language Processing, Application of NLP in Machine Translation, Information Retrieval and Big Data Information Retrieval. Learning: Supervised, Unsupervised and Reinforcement learning. **Artificial Neural Networks** (ANNs): Concept, Feed forward and Feedback ANNs, Error Back Propagation, Boltzmann Machine.

Unit V	Robotics	08 Hours

Robotics: Fundamentals, path Planning for Point Robot, Sensing and mapping for Point Robot, Mobile Robot Hardware, Non Visual Sensors like: Contact Sensors, Inertial Sensors, Infrared Sensors, Sonar, Radar, laser Rangefinders, Biological Sensing. Robot System Control: Horizontal and Vertical Decomposition, Hybrid Control Architectures, Middleware, High-Level Control, Human-Robot Interface.

Unit VI	Robots in Practice	08 Hours

Robot Pose Maintenance and Localization: Simple Landmark Measurement, Servo Control, Recursive Filtering, Global Localization. Mapping: Sensorial Maps, Topological Maps, Geometric Maps, Exploration. Robots in Practice: Delivery Robots, Intelligent Vehicles, Mining Automation, Space Robotics, Autonomous Aircrafts, Agriculture, Forestry, Domestic Robots.

Books:

Text:

1. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1
2. Elaine Rich, Kevin Knight and Nair, “Artificial Intelligence”, TMH, ISBN-978-0-07-008770-5
3. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Third edition, Pearson, 2003, ISBN :10: 0136042597
4. Michael Jenkin, Gregory, “ Computational Principals of Mobile Robotics”, Cambridge University Press, 2010, ISBN : 978-0-52-187157-0

References:

1. Nilsson Nils J , “Artificial Intelligence: A new Synthesis, Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, “Artificial Intelligence”, Addison-Wesley Publishing Company, ISBN: 0-201-53377-4
3. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0

Home

Savitribai Phule Pune University

Fourth Year of Computer Engineering (2015 Course)

410243: Data Analytics

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310242-Database Management Systems

Companion Course: 410246-Laboratory Practice I

Course Objectives:

- To develop problem solving abilities using Mathematics
- To apply algorithmic strategies while solving problems
- To develop time and space efficient algorithms
- To study algorithmic examples in distributed, concurrent and parallel environments

Course Outcomes:

On completion of the course, student will be able to–

- Write case studies in Business Analytic and Intelligence using mathematical models
- Present a survey on applications for Business Analytic and Intelligence
- Provide problem solutions for multi-core or distributed, concurrent/Parallel environments

Course Contents

Unit I	Introduction and Life Cycle	08 Hours

Introduction: Big data overview, state of the practice in Analytics- BI Vs Data Science, Current Analytical Architecture, drivers of Big Data, Emerging Big Data Ecosystem and new approach. Data Analytic Life Cycle: Overview, phase 1- Discovery, Phase 2- Data preparation, Phase 3- Model Planning, Phase 4- Model Building, Phase 5- Communicate Results, Phase 6- Opearationalize. Case Study: GINA

Unit II	Basic Data Analytic Methods	08 Hours

Statistical Methods for Evaluation- Hypothesis testing, difference of means, wilcoxon rank–sum test, type 1 type 2 errors, power and sample size, ANNOVA. Advanced Analytical Theory and Methods: Clustering- Overview, K means- Use cases, Overview of methods, determining number of clusters, diagnostics, reasons to choose and cautions.

Unit III	Association Rules and Regression	08 Hours

Home

Advanced Analytical Theory and Methods: Association Rules- Overview, a-priori algorithm, evaluation of candidate rules, case study-transactions in grocery store, validation and testing, diagnostics. Regression- linear, logistics, reasons to choose and cautions, additional regression models.

Unit IV	Classification	08 Hours

Decision trees- Overview, general algorithm, decision tree algorithm, evaluating a decision tree. Naïve Bayes – Bayes' Algorithm, Naïve Bayes' Classifier, smoothing, diagnostics. Diagnostics of classifiers, additional classification methods.

Unit V	Big Data Visualization	08 Hours

Introduction to Data visualization, Challenges to Big data visualization, Conventional data visualization tools, Techniques for visual data representations, Types of data visualization, Visualizing Big Data, Tools used in data visualization, Analytical techniques used in Big data visualization.

Unit VI	Advanced Analytics-Technology and Tools	08 Hours

Analytics for unstructured data- Use cases, Map Reduce, Apache Hadoop. The Hadoop Ecosystem- Pig, HIVE, HBase, Mahout, NoSQL. An Analytics Project-Communicating, operationalizing, creating final deliverables.

Books:

Text:

1. David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publications, 2012, ISBN0-07-120413-X
2. Ashutosh Nandeshwar , "Tableau Data Visualization Codebook", Packt Publishing, ISBN 978-1-84968-978-6

References:

1. Maheshwari Anil, Rakshit, Acharya, "Data Analytics", McGraw Hill, ISBN: 789353160258.
2. Mark Gardner, "Beginning R: The Statistical Programming Language", Wrox Publication, ISBN: 978-1-118-16430-3
3. Luís Torgo, "Data Mining with R, Learning with Case Studies", CRC Press, Talay and Francis Group, ISBN9781482234893
4. Carlo Vercellis, "Business Intelligence - Data Mining and Optimization for Decision Making", Wiley Publications, ISBN: 9780470753866.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective I
410244(A): Digital Signal Processing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 207003- Engineering Mathematics III

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To Study and understand representation and properties of signals and systems.
- To learn methodology to analyze signals and systems
- To study transformed domain representation of signals and systems
- To explore Design and analysis of Discrete Time (DT) signals and systems
- To Understand Design of filters as DT systems
- To get acquainted with the DSP Processors and DSP applications

Course Outcomes:

On completion of the course, student will be able to–

- Understand the mathematical models and representations of DT Signals and Systems
- Apply different transforms like Fourier and Z-Transform from applications point of view.
- Understand the design and implementation of DT systems as DT filters with filter structures and different transforms.
- Demonstrate the knowledge of signals and systems for design and analysis of systems
- Apply knowledge and use the signal transforms for digital processing applications

Course Contents

Unit I	Signals and Systems	08 Hours

Continuous time (CT), Discrete-time (DT) and Digital signals, Basic DT signals and Operations. Discrete-time Systems, Properties of DT Systems and Classification, Linear Time Invariant (LTI) Systems, Impulse response, Linear convolution, Linear constant coefficient difference equations, FIR and IIR systems, Periodic Sampling, Relationship between Analog and DT frequencies, Aliasing, Sampling Theorem, A to D conversion Process: Sampling, quantization and encoding.

Unit II	Frequency Domain Representation of Signal	08 Hours

Introduction to Fourier Series, Representation of DT signal by Fourier Transform (FT), Properties of FT: Linearity, periodicity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, windowing theorem Discrete Fourier Transform (DFT), DFT and FT, IDFT, Twiddle factor, DFT as linear transformation matrix, Properties of DFT, circular shifting, Circular Convolution, DFT as Linear filtering, overlap save and add, DFT spectral leakage.

Unit III	Fast Fourier Transform (FFT) and Z-Transform (ZT)	08 Hours

Home

Effective computation of DFT, Radix-2 FFT algorithms: DIT FFT, DIF FFT, Inverse DFT using FFT, Z-transform (ZT), ZT and FT, ZT and DFT, ROC and its properties, ZT Properties, convolution, initial value theorem, Rational ZT, Pole Zero Plot, Behavior of causal DT signals, Inverse Z Transform (IZT): power series method, partial fraction expansion (PFE) , Residue method.

Unit IV	Analysis of DT - LTI Systems	08 Hours

System function H(z), H(z) in terms of Nth order general difference equation, all poll and all zero systems, Analysis of LTI system using H(Z), Unilateral Z-transform: solution of difference equation, Impulse and Step response from difference equation, Pole zero plot of H(Z) and difference equation, Frequency response of system, Frequency response from pole-zero plot using simple geometric construction.

Unit V	Digital Filter Design	08 Hours

Concept of filtering, Ideal filters and approximations, specifications, FIR and IIR filters, Linear phase response, FIR filter Design: Fourier Series method, Windowing method, Gibbs Phenomenon, desirable features of windows, Different window sequences and its analysis, Design examples IIR filter design: Introduction, Mapping of S-plane to Z-plane, Impulse Invariance method, Bilinear Z transformation (BLT) method, Frequency Warping, Pre-warping, Design examples, Comparison of IIR and FIR Filters.

Unit VI	Filter Structures and DSP Processors	08 Hours

Filter Structures for FIR Systems: direct form, cascade form, structures for linear phase FIR Systems, Examples, Filter structures for IIR Systems: direct form, cascade form, parallel form, Examples DSP Processors: ADSP 21XX Features, comparison with conventional processor, Basic Functional Block diagram, SHARC DSP Processor Introduction to OMAP (Open Multimedia Application Platform).

Books:

Text:

1. Proakis J, Manolakis D, "Digital Signal Processing", 4th Edition, Pearson Education, ISBN 9788131710005
2. Oppenheium A, Schafer R, Buck J, "Discrete time Signal Processing", 2nd Edition, Pearson Education, ISBN 9788131704929

Reference:

1. Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
2. Ifleachor E. C., Jervis B. W., “Digital Signal Processing: A Practical Approach “, Pearson-Education, 2002, , ISBN-13: 978-0201596199,ISBN-10: 0201596199
3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", McGraw-Hill, ISBN 0-07-463996-X
4. S. Poornachandra, B. Sasikala, “Digital Signal Processing”,3rd Edition, McGraw-Hill, ISBN-13:978-07- 067279-6

Home

Savitribai Phule Pune University

Fourth Year of Computer Engineering (2015 Course)

Elective I

410244(B): Software Architecture and Design

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310243- Software Engineering and Project Management

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To introduce basic concepts and principles about software design and software architecture
- To learn practical approaches and methods for creating and analyzing software architecture
- To acquaint with the interaction between quality attributes and software architecture
- To experience with examples in design pattern application and case studies in software architecture

Course Outcomes:

On completion of the course, student will be able to–

- Express the analysis and design of an application
- Specify functional semantics of an application
- Evaluate software architectures
- Select and use appropriate architectural styles and software design patterns

Course Contents

Unit I	Introduction	08 Hours

Introduction to Software Architecture, Architecture Business Cycle- Where do architecture come from, Software processes and the Architecture Business cycle, What makes Good Architecture. What is software architecture- What Software Architecture is and what it is not, Other points of View, Architectural Patterns, Reference Models, Reference Architectures, Why is Software Architecture important, Architectural structure and Views. Case Study-A-7E Avionics System.

Unit II	Quality Attributes	08 Hours

Introduction to Quality Attributes, Understanding quality attributes- Functionality and Architecture, architecture and quality attributes, System Quality Attributes, Quality Attribute Scenario in Practice, Other System Quality Attributes, Business Qualities, and Architecture Qualities. Achieving quality attributes- Introducing Tactics, Availability tactics, Modifiability tactics, Performance tactics, Security tactics, Testability tactics, Usability tactics, Relationship of tactics to Architectural patterns, Architectural Patterns and Styles. Case study- Air Traffic Control.

Home

Unit III	Designing the Architectures and Introduction to Design Patterns	08 Hours

Architecture in Life Cycle, Designing the Architecture, Forming the team structure, Creating a skeletal system, Case Study- Flight Simulation. Design Patterns: What is Design Pattern?, Describing Design Patterns, The Catalog of Design Patterns, Organizing the Catalog, How Design patterns solves design problems, How to select Design Patterns, How to use Design Patterns.

Unit IV	Design Pattern Catalog	08 Hours

Creational Patterns- Abstract Factory, Singleton. Structural Patterns- Adaptor, Facade, Proxy. Behavioral Patterns- Chain of Responsibility, Iterator, Mediator, Observer. What to expect from Design Patterns.

Unit V	Client Side Technologies	08 Hours

Introduction to three tier and n-Tier Web Architectures, Need of Client side technology in multi-tier architectures, XML, Client side technologies- HTML, DHTML, Java Applets, Active X controls, DOM, AJAX. Case study-Mobile or portable client side technologies.

Unit VI	Middleware and Server Side Technologies	08 Hours

Introduction to Middleware, Types of Middleware, Application servers, Introduction to Java EE, Introduction to Java EE technologies like JMS, JDBC, RPC, RMI, SOCKET. EJB 3.0 Architecture, Entity, Session, Message beans, XML, XSLT. Specifications and characteristics of Middleware technologies. Server Side Technologies- Need of server side technology in multi-tier architectures, Java Web Services, Server side technologies: JSP, JSF, SOA, MVC. Java Servlets, struts.

Books:

Text:

1. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Pearson ,ISBN 978-81-775-8996-2
2. Erich Gamma, “Design Patterns”, Pearson, ISBN 0-201-63361-2.
3. Kogent, “Java Server Programming Black Book”, Dream Tech Press, PHI Publications, ISBN: 978-81-7722-835-9.

References:

1. James L. Weaver, Kevin Mukhar, "Beginning J2EE 1 .4: From Novice to Professional”, ISBN-10: 1590593413, ISBN-13: 978-1590593417
2. Richard N.Taylor , Nenad M., “Software Architecture Foundation Theory and practice”, Wiley ISBN: 978-81-265-2802-8.
3. Java6 Programming, Black Book DreamTech Press, ISBN:978-81-7722-736-9

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective I
410244(C): Pervasive and Ubiquitous Computing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245- Computer Networks

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To understand the characteristics and principles of Pervasive computing
- To introduce to the enabling technologies of pervasive computing
- To understand the basic issues and performance requirements of pervasive computing applications
- To learn the trends of pervasive computing

Course Outcomes:

On completion of the course, student will be able to–

- Design and implement primitive pervasive applications
- Analyze and estimate the impact of pervasive computing on future computing applications and society
- Develop skill sets to propose solutions for problems related to pervasive computing system
- Design a preliminary system to meet desired needs within the constraints of a particular problem space

Course Contents

Unit I	Pervasive Computing	08 Hours

Pervasive Computing, Applications, Pervasive Computing devices and Interfaces, Device technology trends, Connecting issues and protocols. Pervasive Computing- Principles, Characteristics, interaction transparency, context aware, automated experience capture. Architecture for pervasive computing.

Unit II	Open Protocols	08 Hours

Open protocols, Service discovery technologies- SDP, Jini, SLP, UpnP protocols, data Synchronization, SyncML framework, Context aware mobile services, Context aware sensor networks, addressing and communications- Context aware security. Pervasive Computing and web based Applications - XML and its role in Pervasive Computing, Wireless Application Protocol (WAP) Architecture and Security, Wireless Mark-Up language (WML) – Introduction. Moving on from Weiser's Vision of Calm Computing: Engaging UbiComp Experiences.

Unit III	Voice Enabled Pervasive Computing	08 Hours

Home

Voice Enabled Pervasive Computing, Voice Standards, Speech Applications in Pervasive Computing and security. Device Connectivity, Web application Concepts, WAP and Beyond. Voice Technology – Basis of speech Recognition, Voice Standards, Speech Applications, Speech and Pervasive Computing, Security, The Hitchhiker's Guide to UbiComp: Using techniques from Literary and Critical Theory to Reframe Scientific Agendas.

Unit IV	Personal Digital Assistant	08 Hours

Personal Digital Assistant – History, Device Categories, Device Characteristics, Software Components, Standards. Server side programming in Java, Pervasive Web application Architecture, Example Application, Access via PCs, Access via WAP, Access via PDA, and Access via Voice, Pinch Watch: A Wearable Device for One-Handed Micro interactions., Interfaces - Enabling mobile micro-interactions with physiological computing.

Unit V	User Interface	08 Hours

User Interface Issues in Pervasive Computing, Architecture, and Smart Card based Authentication Mechanisms, Wearable computing Architecture. Touche: Enhancing Touch Interaction on Humans, Screens, Liquids, and Everyday Objects

Unit VI	Context Awareness and Application Development	08 Hours

Location as context, Location Tracking, Co-ordinate models, Location Data Sources, sorting and search in location data. Sensing Activity based on various wearable sensors, smart phone sensors. Wearable Computing applications in Healthcare and Assistive Technologies. Developing, Deploying and Evaluating Pervasive computing applications. Application in Augmented Reality.

Books:

Text:

1. Jochen Burkhardt, Horst Henn, Stefan Hepper, Thomas Schaec and Klaus Rindtorff, “Pervasive Computing Technology and Architecture of Mobile Internet Applications”, Addision Wesley, 2002. ISBN:13: 978-0-201-72215-4
2. Uwe Hansman, Lothat Merk, Martin S Nicklous and Thomas Stober: “Principles of Mobile Computing”, Second Edition, Springer- Verlag, New Delhi, 2003, ISBN: 9783662043189

References:

1. Mohammads, Obaidait, Denko, Woungang, “Pervasive Computing and Networking”, Wiley, ISBN:978-0-470-74772-8
2. Seng Loke, “Context-Aware Computing Pervasive Systems”, Auerbach Pub., New York, 2007, ISBN: 978-1-4471-5006-0
3. Uwe Hansmann etl, “Pervasive Computing”, Springer, New York,2001., ISBN: 10: 3540002189
4. John Krumm, "Ubiquitous Computing Fundamentals", Shroff Publishers, ISBN: 9781420093605
5. Adelstein, “Fundamental of Mobile and Pervasive Computing”, McGrawHill, ISBN: 0-07-141237-9

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective I
410244(D): Data Mining and Warehousing

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310242-Database Management Systems, 310244- Information Systems and Engineering Economics

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To understand the fundamentals of Data Mining
- To identify the appropriateness and need of mining the data
- To learn the preprocessing, mining and post processing of the data
- To understand various methods, techniques and algorithms in data mining

Course Outcomes:

On completion of the course the student should be able to-

- Apply basic, intermediate and advanced techniques to mine the data
- Analyze the output generated by the process of data mining
- Explore the hidden patterns in the data
- Optimize the mining process by choosing best data mining technique

Course Contents

Unit I	Introduction	08 Hours

Data Mining, Data Mining Task Primitives, Data: Data, Information and Knowledge; Attribute Types: Nominal, Binary, Ordinal and Numeric attributes, Discrete versus Continuous Attributes; Introduction to Data Preprocessing, Data Cleaning: Missing values, Noisy data; Data integration: Correlation analysis; transformation: Min-max normalization, z-score normalization and decimal scaling; data reduction: Data Cube Aggregation, Attribute Subset Selection, sampling; and Data Discretization: Binning, Histogram Analysis

Unit II	Data Warehouse	08 Hours

Data Warehouse, Operational Database Systems and Data Warehouses(OLTP Vs OLAP), A Multidimensional Data Model: Data Cubes, Stars, Snowflakes, and Fact Constellations Schemas; OLAP Operations in the Multidimensional Data Model, Concept Hierarchies, Data Warehouse Architecture, The Process of Data Warehouse Design, A three-tier data warehousing architecture, Types of OLAP Servers: ROLAP versus MOLAP versus HOLAP.

Unit III	Measuring Data Similarity and Dissimilarity	08 Hours

Home

Measuring Data Similarity and Dissimilarity, Proximity Measures for Nominal Attributes and Binary Attributes, interval scaled; Dissimilarity of Numeric Data: Minskowski Distance, Euclidean distance and Manhattan distance; Proximity Measures for Categorical, Ordinal Attributes, Ratio scaled variables; Dissimilarity for Attributes of Mixed Types, Cosine Similarity.

Unit IV	Association Rules Mining	08 Hours

Market basket Analysis, Frequent item set, Closed item set, Association Rules, a-priori Algorithm, Generating Association Rules from Frequent Item sets, Improving the Efficiency of a-priori, Mining Frequent Item sets without Candidate Generation: FP Growth Algorithm; Mining Various Kinds of Association Rules: Mining multilevel association rules, constraint based association rule mining, Meta rule-Guided Mining of Association Rules.

Unit V	Classification	08 Hours

Introduction to: Classification and Regression for Predictive Analysis, Decision Tree Induction, Rule-Based Classification: using IF-THEN Rules for Classification, Rule Induction Using a Sequential Covering Algorithm. Bayesian Belief Networks, Training Bayesian Belief Networks, Classification Using Frequent Patterns, Associative Classification, Lazy Learners-k-Nearest-Neighbor Classifiers, Case-Based Reasoning.

Unit VI	Multiclass Classification	08 Hours

Multiclass Classification, Semi-Supervised Classification, Reinforcement learning, Systematic Learning, Wholistic learning and multi-perspective learning. Metrics for Evaluating Classifier Performance: Accuracy, Error Rate, precision, Recall, Sensitivity, Specificity; Evaluating the Accuracy of a Classifier: Holdout Method, Random Sub sampling and Cross-Validation.

Books:

Text:

1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques”, Elsevier Publishers, ISBN:9780123814791, 9780123814807.
2. Parag Kulkarni, “Reinforcement and Systemic Machine Learning for Decision Making” by Wiley-IEEE Press, ISBN: 978-0-470-91999-6

References:

1. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition, ISBN: 9780596006068
2. Maksim Tsvetovat, Alexander Kouznetsov, "Social Network Analysis for Startups:Finding connections on the social web", Shroff Publishers , ISBN: 10: 1449306462

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(A): Distributed Systems

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks, 310254-Web Technology, 210254-Principles of Programming Languages

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To understand the concept of Distributed system, remote method invocation and Remote Procedure Calls.
- To learn communication methodology in distributed systems.
- To acquaint with the Distributed File Systems.
- To know the concepts of shared memory and security aspects in distributed system.

Course Outcomes:

On completion of the course, student will be able to–

- Able to learn and apply the concept of remote method invocation and Remote Procedure Calls
- Able to analyze the mechanism of peer to peer systems and Distributed File Systems
- Demonstrate an understanding of the challenges faced by current and future distributed systems

Course Contents

Unit I	Introduction	08 Hours

Characteristics of Distributed Systems(DS): Introduction, Examples of DS, Trends in DS, Sharing Resources, Challenges in DS. System Models: Physical, Architectural and Fundamental Models Remote Invocation : Request Reply protocols, RPC, RMI, Case Study- JAVA RMI.

Unit II	Distributed Algorithms	08 Hours

Representing Distributed Algorithms: Representation Guarded Actions, Non-determinism, Atomic actions, Fairness, Central vs Distributed Scheduler. Time in Distributed Systems: Logical clocks, Vector clocks, Physical Clock Synchronization, Algorithms for Internal and External Clock Synchronization. Mutual Exclusion: Solution to Message passing systems, Token-Passing algorithms, Solutions on shared memory models, Mutual exclusion using special instructions, Group mutual exclusion.

Unit III	Distributed Snapshot	08 Hours

Distributed Snapshot: Properties of Consistent snapshot, Chandy-Lamport algorithm, Lai-Yang algorithm, Distributed debugging. Global state collection : Elementary algorithm for All-to- All broadcasting, Termination Detection algorithm, Wave algorithm, Distributed deadlock detection Coordination Algorithms: Leader Elections, Algorithms like Bully, Maxima finding on the ring, election in arbitrary networks, Election in anonymous networks. Synchronizers: ABD synchronizer, Awerbuch's synchronizers.

Unit IV	Distributed Consensus	08 Hours

Distributed consensus: Consensus in asynchronous systems, Consensus in synchronous systems, Paxo's algorithm, Failure detectors. Distributed Transactions: Classification of transactions, Implementing Transactions, Concurrency control and serializability, Atomic Commit protocols, Recovery from Failures.

Unit V	Group Communication	08 Hours

Group Communication: Atomic multicast, IP Multicast, Application layer multicast, Ordered multicast, Reliable multicast, Open groups. Replicated Data Management: Architecture of replicated Data Management, Data-Centric Consistency models, Client centric consistency protocols, Implementation of Data-Centric Consistency models, Quorum based protocols, Replica Placement, Brewer's CAP algorithm.

Unit VI	Distributed Discrete-Event Simulation	08 Hours

Distributed Discrete-Event Simulation: Distributed simulation, Conservative Simulation, Optimistic simulation and Time warp. Security in DS: Security Mechanisms to thwart various attacks in DS. Social and Peer-to-Peer network: Metrics of Social networks, Modeling Social Networks, Centrality measure in Social network, Community detection, Koorde and De Brujin Graphs, Skip graph, Replication management, Bit-torrent and free riding, Censorship resistance and anonymity.

Books:

Text:

1. George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed Systems, Concepts and Design", Fifth Edition, Addison Wesley, ISBN 0-13-214301-1.
2. Sukumar Ghosh, "Distribute Systems : An Algorithmic Approach", Chapman and Hall, CRC Press, Second Edition, 2015, ISBN 10: 1584885645 ISBN 13: 9781584885641
3. Andrew S. Tanenbaum and Maarten van Steen, "Distributed Systems –Principles and Paradigms" , PHI Publication, ISBN 0-13-239227-5

References:

1. Shvartsman, A.A., Weatherspoon, H.; Zhao, "Future Directions in Distributed Computing Research and Position Papers Series: Lecture Notes in Computer Science" , Vol. 2584 Schiper, (Eds.) 2003, X, 219 p., ISBN: 978-3-540- 00912-2
2. Sape Mullender, "Distributed Systems", (Editor),Addison-Wesley Publication, I*SBN* 10: 0201624273 - ISBN13: 9780201624274
3. Kenneth, P. Birman, "Reliable Distributed Systems: Technologies, Web Services, and Applications", Springer; 1 edition, ISBN-10: 0387215093; ISBN-13: 978-0387215099
4. Galli D.L., "Distributed Operating Systems: Concepts and Practice", Prentice-Hall 2000, ISBN0-13-079843-6

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(B): Software Testing and Quality Assurance

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310243- Software Engineering and Project Management,310263- Software Modeling and Design

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- Introduce basic concepts of software testing
- Understand white box, block box, object oriented, web based and cloud testing
- Know in details automation testing and tools used for automation testing
- Understand the importance of software quality and assurance software systems development.

Course Outcomes:

On completion of the course, student will be able to–

- Describe fundamental concepts in software testing such as manual testing, automation testing and software quality assurance.
- Design and develop project test plan, design test cases, test data, and conduct test operations
- Apply recent automation tool for various software testing for testing software
- Apply different approaches of quality management, assurance, and quality standard to software system
- Apply and analyze effectiveness Software Quality Tools

Course Contents

Unit I	Introduction	08 Hours

Introduction, historical perspective, Definition, Core Components, Quality View, Financial Aspect, Customers suppliers and process, Total Quality Management(TQM), Quality practices of TQM, Quality Management through- Statistical process Control, Cultural Changes, Continual Improvement cycle, quality in different areas, Benchmarking and metrics, Problem Solving Techniques, Problem Solving Software Tools.

Software Quality- Introduction, Constraints of Software product Quality assessment, Customer is a King, Quality and Productivity Relationship, Requirements of Product, Organization Culture, Characteristics of Software, Software Development Process, Types of Product, Criticality Definitions, Problematic areas of SDLC, Software Quality Management, Why Software has defects, Processes related to Software Quality, Quality Management System's Structure, Pillars of Quality Management System, Important aspects of quality management.

Unit II	Test Planning and Management	08 Hours

Home

Review of Fundamentals of Software Testing, Testing during development life cycle, Requirement Traceability matrix, essentials, Work bench, Important Features of Testing Process, Misconceptions, Principles, salient and policy of Software testing, Test Strategy, Test Planning, Testing Process and number of defects found, Test teem efficiency, Mutation testing, challenges, test team approach, Process problem faced, Cost aspect, establishing testing policy, methods, structured approach, categories of defect, Defect/ error/ mistake in software, Developing Test Strategy and Plan, Testing process, Attitude towards testing, approaches, challenges, Raising management awareness for testing, skills required by tester.

Unit III	Software Test Automation	08 Hours

What is Test Automation, Terms used in automation, Skills needed for automation, What to automate, scope of automation, Design and Architecture of automation, Generic requirement for Test Tool, Process Model for Automation, Selecting Test Tool, Automation for XP/Agile model, Challenges in Automation, Data-driven Testing. Automation Tools like JUnit, Jmeter

Unit IV	Selenium Tool	08 Hours

Introducing Selenium, Brief History of The Selenium Project, Selenium's Tool Suite, Selenium-IDE, Selenium RC, Selenium Webdriver, Selenium Grid, Test Design Considerations

Unit V	Quality Management	08 Hours

Software Quality, Software Quality Dilemma, Achieving Software Quality, Software Quality Assurance. Elements of SQA, SQA Tasks, Goals, and Metrics, Formal Approaches to SQA, Statistical Software Quality Assurance, Six Sigma for Software Engineering, ISO 9000 Quality Standards, SQA Plan.

Unit VI	Software Quality Tools	08 Hours

Total Quality Management, Product Quality Metrics, In process Quality Metrics, Software maintenance, Ishikawa's 7 basic tools, Checklists, Pareto diagrams, Histogram, Run Charts, Scatter diagrams, Control chart, Cause Effect diagram. Defect Removal Effectiveness and Process Maturity Level.

Books:

Text:

1. M G Limaye, "Software Testing Principles, Techniques and Tools", Tata McGraw Hill, ISBN: 9780070139909 0070139903
2. Srinivasan Desikan, Gopalswamy Ramesh, "Software Testing Principles and Practices", Pearson, ISBN-10: 817758121X

References:

1. Naresh Chauhan, "Software Testing Principles and Practices ", OXFORD, ISBN-10: 0198061846. ISBN-13: 9780198061847
2. Stephen Kan, "Metrics and Models in Software Quality Engineering", Pearson, ISBN-10: 0133988082; ISBN-13: 978-0133988086

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(C): Operations Research

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210241- Discrete Mathematics, 310243- Software Engineering and Project Management

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To introduce the learners the quantitative methods and techniques for effective analysis of decisions making
- To understand the model formulation and applications that is used in solving business decision problems.
- To introduce the optimization approaches and fundamental solution.
- To learn a variety of ways in which deterministic and stochastic models in Operations Research can be used

Course Outcomes:

On completion of the course, student will be able to–

- Identify the characteristics of different types of decision-making environments
- Use appropriate decision making approaches and tools
- Build various dynamic and adaptive models
- Develop critical thinking and objective analysis of decision problems
- Apply the OR techniques for efficacy

Course Contents

Unit I	Linear Programming	08 Hours

Introduction, Modeling with Liner Programming, Two variable LP model, Graphical LP solutions for both maximization and minimization models with various application examples, LP model in equation form, simplex method, special case in simplex method, artificial starting solution, Degeneracy in LPP, Unbounded and Infeasible solutions.

Unit II	Duality in Linear Programming and Revised Simplex Method	08 Hours

Duality theory: a fundamental insight. The essence of duality theory, Economic interpretation of duality, Primal dual relationship; Adapting to other primal forms, The revised simplex method- development of optimality and feasibility conditions, Revised Simplex Algorithms.

Unit III	The Transportation Problem and Assignment Problem	08 Hours

Finding an initial feasible solution - North West-corner method, Least cost method, Vogel's Approximation method, Finding the optimal solution, optimal solution by stepping stone and MODI methods, Special cases in Transportation problems - Unbalanced Transportation problem. Assignment Problem: Hungarian method of Assignment problem, Maximization in Assignment problem, unbalanced problem, problems with restrictions, travelling salesman problems.

Unit IV	Game Theory and Dynamic Programming	08 Hours

Introduction, 2 person zero sum games, Minimax, Maximin principle, Principle of Dominance, Solution for mixed strategy problems, Graphical method for 2 x n and m x 2 games. Recursive nature of computations in Dynamic Programming, Forward and backward recursion, Dynamic Programming Applications – Knapsack, Equipment replacement, Investment models

Unit V	Integer Programming Problem and Project Management	08 Hours

Integer Programming Algorithms – BandB Algorithms, cutting plane algorithm, Gomory's All-IPP Method, Project Management: Rules for drawing the network diagram, Application of CPM and PERT techniques in project planning and control; Crashing and resource leveling of operations Simulation and its uses in Queuing theory and Materials Management

Unit VI	Decision Theory and Sensitivity Analysis	08 Hours

Decision making under certainty, uncertainty and risk, sensitivity analysis, Goal programming formulation and algorithms – The weights method, The preemptive method

Books:

Text:

1. Hamdy A. Taha, "Operations Research" , Pearson Education, 8th Edition, ISBN: 978-81-317-1104-0
2. Gillett, "Introduction to Operations Research", TMH, ISBN: 0070232458

References:

1. S.D. Sharma, Kedarnath, Ramnath and Co, "Operations Research", 2009, ISBN:978-81-224-2288-7
2. Hrvey M. Wagner, "Principles of Operations Research", Second Edition, Prentice Hall of India Ltd., 1980, ISBN: 10: 0137095767, 13: 9780137095766..
3. V.K. Kapoor, "Operations Research", S. Chand Publishers, New Delhi, 2004, ISBN: 9788180548543, 8180548546.
4. R. Paneer Selvam, "Operations Research", Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008, ISBN: 10: 8120329287,: 9788120329287.

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(D): Mobile Communication

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To understand the Personal Communication Services
- To learn the design parameters for setting up mobile network
- To know GSM architecture and support services
- To learn current technologies being used on field

Course Outcomes:

On completion of the course, student will be able to–

- Justify the Mobile Network performance parameters and design decisions.
- Choose the modulation technique for setting up mobile network.
- Formulate GSM/CDMA mobile network layout considering futuristic requirements which conforms to the technology.
- Use the 3G/4G technology based network with bandwidth capacity planning.
- Percept to the requirements of next generation mobile network and mobile applications.

Course Contents

Unit I	Introduction to Cellular Networks	08 Hours

Cell phone generation-1G to 5G, Personal Communication System (PCS), PCS Architecture, Mobile Station,, SIM, Base Station, Base Station Controller, Mobile Switching Center, MSC Gateways, HLR and VLR, AuC/EIR/OSS, Radio Spectrum, Free Space Path Loss, S/N Ratio, Line of sight transmission, Length of Antenna, Fading in Mobile Environment.

Unit II	Cellular Network Design	08 Hours

Performance Criterion, Handoff/Hanover, Frequency Reuse, Co-channel Interference and System Capacity, Channel Planning, Cell Splitting, Mobility Management in GSM and CDMA.

Unit III	Medium Access Control	08 Hours

Specialized MAC, SDMA, FDMA, TDMA, CDMA, Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS), GMSK Modulation, 8PSK, 64 QAM, 128 QAM and OFDM

Unit IV	GSM	08 Hours

GSM – Architecture, GSM Identifiers, Spectrum allocation, Physical and Logical Traffic and Control channels, GSM Bursts, GSM Frame, GSM Speech Encoding and decoding, Location Update, Incoming and Outgoing Call setup, GPRS.

Home

Unit V	Current 3G and 4G Technologies for GSM and CDMA	08 Hours
EDGE, W-CDMA: Wideband CDMA, CDMA2000, UMTS, HSPA (High Speed Packet Access), HSDPA, HSUPA, HSPA+, LTE (E-UTRA) 3GPP2 family CDMA2000 1x, 1xRTT, EV-DO (Evolution-Data Optimized), Long Term Evolution (LTE) in 4G.		
Unit VI	**Advances in Mobile Technologies**	**08 Hours**
5GAA (Autonomous Automation), Millimetre Wave, URLLC, LTEA (Advanced), LTE based MULTIFIRE, Virtual Reality, Augmented Reality.		

Books:

Text:

1. Jochen Schiller, "Mobile Communications", Pearson Education, Second Edition, 2004, ISBN: 13: 978-8131724262
2. Jason Yi-Bing Lin, Yi-Bing Lin, Imrich Chlamtac, "Wireless and Mobile network Architecture", 2005, Wiley Publication, ISBN: 978812651560
3. Martin Sauter, "3G, 4G and Beyond: Bringing Networks, Devices and the Web Together", 2012, ISBN-13: 978-1118341483

References:

1. Theodore S Rappaport, "Wireless Communications – Principles and Practice" , Pearson Education India, Second Edition, 2010, ISBN: 978-81-317-3186-4
2. Lee and Kappal, "Mobile Communication Engineering", Mc Graw Hill, ISBN:
3. William Stallings, "Wireless Communication and Networks", Prentice Hall, Second Edition, 2014, ISBN: 978-0131918351

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410246:Laboratory Practice I

Teaching Scheme:	Credit	Examination Scheme:
Practical : 04 Hours/Week	02	Term Work: 50 Marks Practical: 50 Marks

Companion Courses: 410241, 410242 and 410243

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the core courses.

About

Laboratory Practice I is for practical hands on for core courses High Performance Computing, AI & Robotics, and Data Analytics.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative
Programming Languages: C++/JAVA/PYTHON/R
Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal may consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Home

Continuous assessment of laboratory work is to be done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed.
- During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising boost to the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Suggested List of Laboratory Assignments & Mini Projects

(any 04 assignments per High Performance Computing, AI, and Data Analytics and Mini-project per course)

410241:: High Performance Computing

Note: for all programming assignments of HPC-

- Select the suitable model of a parallel computation (Data parallel model, Task graph model, Work pool model, Master slave model , Producer consumer or pipeline model, Hybrid model or other) for algorithm to be developed by considering a strategy for dividing the data, processing method and suitable strategy to reduce interactions.
- Assume suitable processor model, topology, load distribution strategy and Communication.
- Utilize all available resources.
- Test on data set of sufficiently large size
- Compute Total cost and Efficiency as

  Total Cost = Time complexity × Number of processors used

  Efficiency = WCSA/ WCPA

  (WCSA--Worst case execution time of sequential algorithm and WCPA--Worst case execution time of the parallel algorithm)
- Compare performance by varying number of processors used and also with sequential algorithm.

1.	a) Implement Parallel Reduction using Min, Max, Sum and Average operations. b) Write a CUDA program that, given an N-element vector, find- •The maximum element in the vector •The minimum element in the vector

Home

	•The arithmetic mean of the vector •The standard deviation of the values in the vector Test for input N and generate a randomized vector V of length N (N should be large). The program should generate output as the two computed maximum values as well as the time taken to find each value.
2.	**Vector and Matrix Operations-** Design parallel algorithm to 1. Add two large vectors 2. Multiply Vector and Matrix 3. Multiply two N × N arrays using n^2 processors
3.	**Parallel Sorting Algorithms-** For Bubble Sort and Merger Sort, based on existing sequential algorithms, design and implement parallel algorithm utilizing all resources available.
4.	**Parallel Search Algorithm-** Design and implement parallel algorithm utilizing all resources available. for • **Binary Search for Sorted Array** • **Depth-First Search (** tree or an undirected graph) **OR** • **Breadth-First Search (** tree or an undirected graph) **OR** • **Best-First Search that (** traversal of graph to reach a target in the shortest possible path)
5.	Parallel Implementation of the K Nearest Neighbors Classifier
	Sample Mini Projects
6.	**Compression Module (Image /Video)** Large amount of bandwidth is required for transmission or storage of images. This has driven the research area of image compression to develop parallel algorithms that compress images. **OR** For video: RGB To YUV Transform concurrently on many core GPU
7.	**Generic Compression** Run length encoding concurrently on many core GPU
8.	**Encoding** Huffman encoding concurrently on many core GPU
9.	**Database Query Optimization** Long running database Query processing in parallel
	410242: Artificial Intelligence and Robotics
1.	Implement Tic-Tac-Toe using A* algorithm
2.	Implement 3 missionaries and 3 cannibals problem depicting appropriate graph. Use A* algorithm.
3.	Solve 8-puzzle problem using A* algorithm. Assume any initial configuration and define goal configuration clearly.
4.	Define the operators for controlling domestic robot; use these operators to plan an activity to be executed by the robot. For example, transferring two/three objects one over the other from one place to another. Use Means-Ends analysis with all the steps revealed.
5.	Implement any one of the following Expert System , • Medical Diagnosis of 10 diseases based on adequate symptoms

<table>
<tr><td></td><td>Identifying birds of India based on characteristics</td></tr>
<tr><td>6.</td><td>Implement alpha-beta pruning graphically with proper example and justify the pruning.</td></tr>
<tr><td>7.</td><td>Develop elementary chatbot for suggesting investment as per the customers need.</td></tr>
<tr><td>8.</td><td>Solve following 6-tiles problem stepwise using A* algorithm,
<table>
<tr><td>Initial Configuration</td><td>B</td><td>W</td><td>B</td><td>W</td><td>B</td><td>W</td><td></td></tr>
<tr><td>Final Configuration</td><td>B</td><td>B</td><td>B</td><td>W</td><td>W</td><td>W</td><td></td></tr>
</table>
Constraint: Tiles can be shifted left or right 1 or 2 positions with cost 1 and 2 respectively.</td></tr>
<tr><td>9.</td><td>Implement goal stack planning for the following configurations from the blocks world,

</td></tr>
<tr><td>10.</td><td>Use Heuristic Search Techniques to Implement Hill-Climbing Algorithm.</td></tr>
<tr><td>11.</td><td>Use Heuristic Search Techniques to Implement Best first search (Best-Solution but not always optimal) and A* algorithm (Always gives optimal solution).</td></tr>
<tr><td>12.</td><td>Constraint Satisfaction Problem:
Implement crypt-arithmetic problem or n-queens or graph coloring problem (Branch and Bound and Backtracking)</td></tr>
<tr><td>13.</td><td>Implement syntax analysis for the assertive English statements. The stages to be executed are,
Sentence segmentation
Word tokenization
Part-of-speech/morpho syntactic tagging
Syntactic parsing (Use any of the parser like Stanford)</td></tr>
<tr><td>14.</td><td>Mini Projects based on Robotics..</td></tr>
<tr><td colspan="2">410243:: Data Analytics</td></tr>
<tr><td>1.</td><td>Download the Iris flower dataset or any other dataset into a DataFrame. (eg https://archive.ics.uci.edu/ml/datasets/Iris) Use Python/R and Perform following –
How many features are there and what are their types (e.g., numeric, nominal)?
Compute and display summary statistics for each feature available in the dataset. (eg. minimum value, maximum value, mean, range, standard deviation, variance and percentiles
Data Visualization-Create a histogram for each feature in the dataset to illustrate the feature distributions. Plot each histogram.
Create a boxplot for each feature in the dataset. All of the boxplots should be combined into a single plot. Compare distributions and identify outliers.</td></tr>
<tr><td>2.</td><td>Download Pima Indians Diabetes dataset. Use Naive Bayes’ Algorithm for classification
Load the data from CSV file and split it into training and test datasets.
summarize the properties in the training dataset so that we can calculate probabilities and make predictions.
Classify samples from a test dataset and a summarized training dataset.</td></tr>
<tr><td>3.</td><td>Write a Hadoop program that counts the number of occurrences of each word in a text file.</td></tr>
<tr><td>4.</td><td>Write a program that interacts with the weather database. Find the day and the station with the maximum snowfall in 2013.</td></tr>
<tr><td>5.</td><td>Use Movies Dataset. Write the map and reduce methods to determine the average ratings of</td></tr>
</table>

Home

	movies. The input consists of a series of lines, each containing a movie number, user number, rating, and a timestamp: The map should emit movie number and list of rating, and reduce should return for each movie number a list of average rating.
6.	Trip History Analysis: Use trip history dataset that is from a bike sharing service in the United States. The data is provided quarter-wise from 2010 (Q4) onwards. Each file has 7 columns. Predict the class of user. Sample Test data set available here https://www.capitalbikeshare.com/trip-history-data
7.	Bigmart Sales Analysis: For data comprising of transaction records of a sales store. The data has 8523 rows of 12 variables. **Predict the sales of a store.** Sample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problem-big-mart-sales-iii/
8.	Twitter Data Analysis: **Use** Twitter data for sentiment analysis. The dataset is 3MB in size and has 31,962 tweets. **Identify the tweets which are hate tweets and which are not.** **S**ample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problem-twitter-sentiment-analysis/
9.	Time Series Analysis: Use time series and forecast traffic on a mode of transportation. Sample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problem-time-series-2/

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410247:Laboratory Practice II

Teaching Scheme:	Credit	Examination Scheme:
Practical : 04 Hours/Week	02	Term Work: 50 Marks Presentation: 50 Marks

Companion Courses: 410244 and 410245

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the core courses. Enough choice is provided to the learner to choose an elective of one's interest.

Laboratory Practice II is companion lab for elective course I and elective course II.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative

Programming Languages: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend: MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal may consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

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Home

Continuous assessment of laboratory work is to be done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- **It is recommended to conduct examination based on Mini-Project(s) Demonstration and related skill learned.** Team of 2 to 3 students may work on mini-project. During the assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation and software engineering approach followed.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding, effective and efficient implementation and demonstration skills.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Suggested List of Laboratory Assignments& Mini Projects

Recommended / Sample set of assignments and mini projects for reference for all four courses offered for Elective I and for all four courses offered for Elective II. Respective Student have to complete laboratory work for elective I and II that he/she has opted.

410244: Elective I

410244(A) : Digital Signal Processing

1.	Develop a program to generate samples of sine, Cosine and exponential signals at specified sampling frequency and signal parameters. (Test the results for different analog frequency (F) and sampling frequency (Fs)).
2.	Find the output of a system described by given difference equation and initial conditions for given input sequence. (Solution of difference equation) (Obtain the response for different systems by changing Degree of difference equation (N) and coefficients and also for different input sequence x(n). Observe the response by considering system as FIR and IIR system).
3.	Write a program to plot the magnitude and phase response of a Fourier Transform (FT). (Observe the spectrum for different inputs. Observe the Periodicity).
4.	Find the N point DFT / IDFT of the given sequence x (n). Plot the magnitude spectrum |X(K)| Vs K. (Analyze the output for different N and the same input sequence x(n). Also observe the periodicity and symmetry property).
5.	Find the N point circular convolution of given two sequences. Test it for Linear convolution. Compute the circular convolution of given two sequences using DFT and IDFT.
6.	Develop a program to plot the magnitude and phase response of a given system (given: h(n): impulse response of system S) (Observe the frequency response for different systems.

Home

	Compare the frequency response of a system (filter) for different length h(n) i.e filter coefficients).
7.	**Mini-Project 1:** Design and Develop the N-point radix-2 DIT or DIF FFT algorithm to find DFT or IDFT of given sequence x (n). (Analyze the output for different N. Program should work for any value of N and output should be generated for all intermediate stages.)
8.	**Mini-Project 2:** Obtain the Fourier transform of different window functions to plot the magnitude and phase spectrums. (Window functions: Rectangular, Triangular, Bartlett, Hamming, Henning, Kaiser. Observe and compare the desirable features of window sequences for different length. Observe the main and side lobes).
9.	**Mini-Project 3:** Design an FIR filter from given specifications using windowing method. (Application should work for different types of filter specifications i.e. LPF, HPF, BPF etc and all window sequences. Plot the frequency response for different frequency terms i.e. analog and DT frequency).
10.	**Mini-Project 4:** Design of IIR filter for given specifications using Bilinear Transformation. (Generalized code to accept any filter length for a transfer function H(Z). Application should work for different types of filter specifications that is LPF, HPF, BPF etc. and for different transfer functions of an analog filter).
410244(B): Software Architecture and Design Patterns	
1.	**Mini-Project 1**: Narrate concise System Requirements Specification and organize the problem domain area into broad subject areas and identify the boundaries of problem/system. Identify and categorize the target system services with detailed service specifications modeled with component diagram incorporating appropriate architectural style and coupling. Design the service layers and tiers modeled with deployment diagram accommodating abstraction, autonomy, statelessness and reuse. Map the service levels and primitives to appropriate Strategies for data processing using Client-Server Technologies as applicable.
2.	**Mini-Project 2:** Select a moderately complex system and narrate concise requirement specification for the same. Design the system indicating system elements organizations using applicable architectural styles and design patterns with the help of a detailed Class diagram depicting logical architecture. Specify and document the architecture and design pattern with the help of templates. Implement the system features and judge the benefits of the design patterns accommodated.
410244(C): Pervasive and Ubiquitous Computing	
Mini-Projects are to be designed so as to use, • No / minimal extra hardware, • uses open source software's, • need hardly any subscription / telephony / data charges.	
1.	Design and build a sensing system using micro-controllers like - Arduino / Raspberry Pi / Intel Galileo to sense the environment around them and act accordingly.
2.	Design and build a mobile application with context awareness to determine the remaining battery level depending on the users current usage patterns.
3.	Design and build a music streaming system and a smart mobile application to use the speakers or headphones of the smart phone of multiple phones to stream stored / live music during a party (instead of using large speakers).
4.	Smart Mobile Application with orientation sensing for users to put the phone in meeting / silent mode- OR- outdoor/ loud mode based on the orientation of the device. -OR- Smart Mobile Application with ambient sound / noise sensing to adjust the volume of the phone automatically. -OR- Smart Mobile Application with ambient light sensing to adjust the screen brightness automatically.

5.	**Mini-Project 1:** Smart Mobile Application for Location-Based Messaging Design and build a Location-Based Messaging system where users have commented on various eating joints in the area you currently are. The mobile application should give you inputs / recommendations / suggestions on which eating joints are preferred by whom and for what eating items, with their ratings etc.
6.	**Mini-Project 2:** Smart Mobile Application as a Museum Guide Build a Mobile Application as a museum guide, the device scans the QR codes on the artifacts and gives an interactive detailed explanation using Audio / Text / Video about the museum artifact. using location of the user and the list of previously seen artifacts, the mobile application can suggest / recommend which next artifacts to be seen be the user
7.	**Mini-Project 3:** Smart Mobile Application as a Travel / Route Guide, Scenario - You are visiting an ancient monument. There is no local guide available. The previous users have commented on various locations where artifacts can be seen, photo are uploaded. The smart mobile application will give you directions / recommendations / suggestions on what to see and where, including narratives on the same.
8.	**Mini-Project 4:** Design and build a 'Multifunctional Application' in the Mobile and Pervasive domain. The choice of application is to be determined so as to leverage the capabilities of typical smart devices. These include such characteristics as, • Location awareness and GPS systems • Accelerometers • Messaging • Sensor detection capability • Microphone and Camera • Media Player • Touch screen • Mapping Technology • Mobile Web Services
	410244(D): Data Mining and Warehousing
1.	For an organization of your choice, choose a set of business processes. Design star / snow flake schemas for analyzing these processes. Create a fact constellation schema by combining them. Extract data from different data sources, apply suitable transformations and load into destination tables using an ETL tool. **For Example:** Business Origination: Sales, Order, Marketing Process.
2.	Consider a suitable dataset. For clustering of data instances in different groups, apply different clustering techniques (minimum 2). Visualize the clusters using suitable tool.
3.	Apply a-priori algorithm to find frequently occurring items from given data and generate strong association rules using support and confidence thresholds. **For Example:** Market Basket Analysis
4.	Consider a suitable text dataset. Remove stop words, apply stemming and feature selection techniques to represent documents as vectors. Classify documents and evaluate precision, recall.
5.	**Mini project on classification:** Consider a labeled dataset belonging to an application domain. Apply suitable data preprocessing steps such as handling of null values, data reduction, discretization. For prediction of class labels of given data instances, build classifier models using different techniques (minimum 3), analyze the confusion matrix and compare these models. Also apply cross validation while preparing the training and testing datasets.

Home

	For Example: Health Care Domain for predicting disease.

410245: Elective II

410245(A): Distributed Systems

1.	Design and develop a basic prototype distributed system (e.g. a DFS).
2.	Design and implement client server application using RPC/ RMI mechanism (Java)
3.	Design and implement a clock synchronization algorithm for prototype DS
4.	Implement Ring or Bully election algorithm for prototype DS.
5.	Implement Ricart Agrawala's distributed algorithm for mutual exclusion.
6.	Problem solving of Wait-die and Wait –wound scheme for deadlock prevention.
7.	Simulate Wait for Graph based Centralized or Hierarchical or Distributed algorithm for deadlock detection.
8.	Implementation of 2PC / Byzantine Generals Problem

Mini-Projects

Important properties your system should have:

• The system must support multiple, autonomous agents (either human or automated) contending for shared resources and performing real-time updates to some form of shared state.

• The state of the system should be distributed across multiple client or server nodes.

The only centralized service should be one that supports users logging on, adding or removing clients or servers, and other housekeeping tasks.

•The system should be robust

The system should be able to continue operation even if one of the participant nodes crashes.

It should be possible to recover the state of a node following a crash, so that it can resume operation.

We will let you choose your own application, and we will give you wide latitude in the overall and the detailed design of your implementation.

Design, implement, and thoroughly test a distributed system, implementing - Shared document editing, in the style of Google docs. The system should support real-time editing and viewing by multiple participants. Multiple replicas would be maintained for fault tolerance. Caching and/or copy migration would be useful to minimize application response time.

Design, implement, and thoroughly test a distributed system, implementing - A low-latency notification system. E.g., watch a whole bunch of RSS feeds and send all subscribers an email when one is updated. Interface with both the raw RSS feeds and Google's update notification service. Replicate and partition the state of the monitoring system so that it can scale and survive node failures.

Design, implement, and thoroughly test a distributed system, implementing - An airline reservation system. Each airline would maintain its own collection of servers, with enough state replication to enable automatic fail-over. It would be possible to book travel that involves multiple airlines.

Design, implement, and thoroughly test a distributed system, implementing - Implement a distributed file system that does something interesting. Maybe you want one for storing your MP3s or movies. Or perhaps for something entirely different.

410245(B): Software Testing and Quality Assurance

1.	**Mini-Project 1:** Create a small application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Prepare Test Cases inclusive of Test Procedures for identified Test Scenarios. Perform selective Black-box and White-box testing covering Unit and Integration test by using suitable Testing tools. Prepare Test Reports based on Test Pass/Fail Criteria and judge the acceptance of application developed.

2. **Mini-Project 2:** Create a small web-based application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Narrate scripts in order to perform regression tests. Identify the bugs using Selenium WebDriver and IDEand generate test reports encompassing exploratory testing.

410245(C):: Operations Research

1. **The Transportation Problem:**
Milk in a milk shed area is collected on three routes A, B and C. There are four chilling centers P, Q, R and S where milk is kept before transporting it to a milk plant. Each route is able to supply on an average one thousand liters of milk per day. The supply of milk on routes A, B and C are 150, 160 and 90 thousand liters respectively. Daily capacity in thousand liters of chilling centers is 140, 120, 90 and 50 respectively. The cost of transporting 1000 liters of milk from each route (source) to each chilling center (destination) differs according to the distance. These costs (in Rs.) are shown in the following table

Routes	Chilling Centers			
	P	Q	R	S
A	16	18	21	12
B	17	19	14	13
C	32	11	15	10

The problem is to determine how many thousand liters of milk is to be transported from each route on daily basis in order to minimize the total cost of transportation.

2. **Investment Problem:**
A portfolio manager with a fixed budget of $100 million is considering the eight investment opportunities shown in Table 1. The manager must choose an investment level for each alternative ranging from $0 to $40 million. Although an acceptable investment may assume any value within the range, we discretize the permissible allocations to intervals of $10 million to facilitate the modeling. This restriction is important to what follows. For convenience we define a unit of investment to be $10 million. In these terms, the budget is 10 and the amounts to invest are the integers in the range from 0 to 4. Following table provides the net annual returns from the investment opportunities expressed in millions of dollars. A ninth opportunity, not shown in the table, is available for funds left over from the first eight investments. The return is 5% per year for the amount invested, or equivalently, $0.5 million for each $10 million invested. The manager's goal is to maximize the total annual return without exceeding the budget

Returns from Investment Opportunities

Amount Invested ($10 million)	*Opportunity* 1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	4.1	1.8	1.5	2.2	1.3	4.2	2.2	1.0
2	5.8	3.0	2.5	3.8	2.4	5.9	3.5	1.7
3	6.5	3.9	3.3	4.8	3.2	6.6	4.2	2.3
4	6.8	4.5	3.8	5.5	3.9	6.8	4.6	2.8

410245(D):: Mobile Communication

1. Design simple GUI application with activity and intents e.g. Design an android Application for Phone Call or Calculator

2. Design an android application for media player.

3. Design an android Application for SMS Manager

Home

4.	Design an android Application using Google Map To Trace The Location of Device
5.	Design an android Application for Frame Animation
6.	**Mini-Project 1:** Design mobile app to perform the task of creating the splash screen for the application using timer, camera options and integrate Google map API on the first page of the application. Make sure map has following features: • Zoom and View change • Navigation to specific locations • Marker and getting location with touch • Monitoring of location
7.	**Mini-Project 2:** Create an app to add of a product to SQLite database and make sure to add following features • SMS messaging and email provision • Bluetooth options • Accessing Web services • Asynchronous remote method call • Use Alert box for user notification
8.	**Mini-Project 3:** Create the module for collecting cellular mobile network performance parameters using telephony API Manager • Nearest Base Station • Signal Strengths • SIM Module Details • Mobility Management Information
9.	**Mini-Project 4:** Create an application for Bank using spinner, intent • Form 1: Create a new account for customer, Form 2: Deposit money in customer account. Link both forms, after completing of first form the user should be directed to the second form. Provide different menu options
10.	**Mini-Project 5:** Create the module for payment of fees for College by demonstrating the following methods. • Fees Method()- for calculation of fees, Use customized Toast for successful payment of fees, Implement an alarm in case someone misses out on the fee submission deadline • Demonstrate the online payment gateway.

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410248:Project Work Stage I

Teaching Scheme:	Credit	Examination Scheme:
Practical : 02 Hours/Week	02	Presentation: 50 Marks

Course Objectives:

- To Apply the knowledge for solving realistic problem
- To develop problem solving ability
- To Organize, sustain and report on a substantial piece of team work over a period of several months
- To Evaluate alternative approaches, and justify the use of selected tools and methods,
- To Reflect upon the experience gained and lessons learned,
- To Consider relevant social, ethical and legal issues,
- To find information for yourself from appropriate sources such as manuals, books, research journals and from other sources, and in turn increase analytical skills.
- To Work in TEAM and learn professionalism.

Course Outcomes:

On completion of the course, student will be able to–

- Solve real life problems by applying knowledge.
- Analyze alternative approaches, apply and use most appropriate one for feasible solution.
- Write precise reports and technical documents in a nutshell.
- Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work, Inter-personal relationships, conflict management and leadership quality.

Guidelines

Project work Stage – I is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design. The student is expected to complete the project at least up to the design phase. As a part of the progress report of project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies.

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5

In addition to credits, it is recommended that there should be audit course in preferably in each semester from second year to supplement their knowledge and skills. Student will be awarded the bachelor‘s degree if he/she earns 190 credits and clears all the audit courses specified in the syllabus. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course's inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level itself. Method of conduction and method of assessment for audit courses are suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself. (Ref- http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction and Assessment(Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini Project
- Hands on experience on specific focused topic

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report

Audit Course 3 Options

AC5- I	Entrepreneurship Development
AC5-II	Botnet of Things
AC5-III	3D Printing
AC5-IV	Industrial Safety and Environment Consciousness
AC5-V	Emotional Intelligence
AC5-VI	MOOC-Learn New Skill

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier
http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – I: Entrepreneurship Development

This Course Aims at Instituting Entrepreneurial skills in the students by giving an overview of, who the entrepreneurs are and what competences are needed to become an entrepreneur.

Course Objectives:

- To introduce the aspects of Entrepreneurship
- To acquaint with legalities in product development
- To understand IPR, Trademarks, Copyright and patenting
- To know the facets of functional plans, Entrepreneurial Finance and Enterprise Management

Course Outcomes:

On completion of the course, learner will be able to–

- Understand the legalities in product development
- Undertake the process of IPR, Trademarks, Copyright and patenting
- Understand and apply functional plans
- Manage Entrepreneurial Finance
- Inculcate managerial skill as an entrepreneur

Course Contents:

1. **Introduction:** Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmers; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.
2. **Creating Entrepreneurial Venture :** Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership – components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection - Patents Trademarks and Copyrights.
3. **Functional plans:** Marketing plan–for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, Ratio Analysis.
4. **Entrepreneurial Finance:** Debt or equity financing, Sources of Finance - Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India.
5. **Enterprise Management:** Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers and acquisitions

Books:

1. Kumar, Arya,`` Entrepreneurship: Creating and Leading an Entrepreneurial Organization'', Pearson ISBN-10: 8131765784; ISBN-13: 978-8131765784 ...
2. Hishrich., Peters, ``Entrepreneurship: Starting, Developing and Managing a New Enterprise'', ISBN 0-256-14147- 9
3. Irwin Taneja, ``Entrepreneurship,'' Galgotia Publishers. ISBN: 978-93-84044-82-4
4. Charantimath, Poornima, ``Entrepreneurship Development and Small Business Enterprises,'' Pearson Education, ISBN, 8177582607, 9788177582604.

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – II: Botnet of Things

This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

Course Objectives:

- To Understand the various IoT Protocols
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To learn the concept of Botnet

Course Outcomes:

On completion of the course, learner will be able to–

- Implement security as a culture and show mistakes that make applications vulnerable to attacks.
- Understand various attacks like DoS, buffer overflow, web specific, database specific, web - spoofing attacks.
- Demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications

Course Contents:

1. **Introduction**
2. **IRC-Based Bot Networks**
3. **Anatomy of a Botnet: The Gaobot Worm**
4. **IoT Senosors and Security :** Sensors and actuators in IoT, Communication and networking in IoT, Real-time data collection in IoT, Data analytics in IoT , IoT applications and requirements, Security threats and techniques in IoT, Data trustworthiness and privacy in IoT, Balancing utility and other design goals in IoT , Future of Botnets in the Internet of Things, Thingbots, Elements of Typical IRC Bot Attack , Malicious use of Bots and Botnet
5. **Service Layer Protocols and Security :** Security: PHP Exploits, Cross-Site Scripting and Other Browser-Side Exploits, Bots and Botnets, Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols –MAC 802.15.4 , 6LoWPAN, RPL, Application Layer Transport and Session layer protocols- transport Layer (TCP, MPTCP, UDP, DCCP, SCTP) - (TLS, DTLS) – Session Layer - HTTP, CoAP, XMPP, AMQP, MQTT

Books:

1. Bernd Scholz - Reiter, Florian Michahelles, “Architecting the Internet of Things”, Springer ISBN 978 – 3 – 642 – 19156 - 5 e - ISBN 978 – 3 -642 - 19157 - 2,
2. Threat Modeling, Frank Swiderski and Window Snyder,Microsoft Professional, 1 st Edition 2004
3. Gunter Ollmann 2007. The Phishing Guide Understanding and Preventing Phishing Attacks. IBM Internet Security Systems.
4. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978 – 1 – 118 – 47347 - 4, Willy Publications
5. White Papers :- https://www.sans.org/reading-room/whitepapers/malicious/bots-botnet-overview-1299
6. https://www-01.ibm.com/marketing/iwm/dre
7. Mike Kuniavsky, “Smart Things: Ubiquitous Computing User Experience Design,” Morgan Kaufmann Publishers.

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – III: 3D Printing

Home

Course Objectives:

- To understand the principle of 3D printing
- To understand resource requirements of 3D printing
- To know the basic artwork needed for 3D printing

Course Outcomes:

On completion of the course, learner will be able to–

- Apply models for 3D printing
- Plan the resources for 3D printing
- Apply principles in 3D printing in real world

Course Contents:

1. Getting Started with 3D Printing: How 3D Printers Fit into Modern Manufacturing, Exploring the Types of 3D Printing, Exploring Applications of 3D Printing.

2. Outlining 3D Printing Resources: Identifying Available Materials for 3D Printing, Identifying Available Sources for 3D Printable Objects.

3. Exploring the Business Side of 3D Printing: Commoditizing 3D Printing, Understanding 3D Printing's Effect on Traditional lines of Business, Reviewing 3D Printing Research.

4. Employing Personal 3D printing Devices: Exploring 3D printed Artwork, Considering Consumer level 3D Printers, Deciding on RepEap of Your Own.

Books:

1. Richard Horne, Kalani Kirk Hausman, " 3D Printing for Dummies", Taschenbuch, ISBN: 9781119386315
2. Greg Norton, "3D Printing Business - 3D Printing for Beginners - How to 3D Print" ,ISBN:9781514785669
3. Liza Wallach Kloski and Nick Kloski, " Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution", Maker Media, ISBN: 1680450204
4. Jeff Heldrich , "3D Printing: Tips on Getting Started with 3D Printing to Help you make Passive income for your Business"

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – IV: Industrial Safety and Environment Consciousness

Objective of Industrial Safety, Health Environment and Security covers virtually every important area in administration of SHE. It broadly discusses the major problems in safety management, occupational health and today's dynamic environment management of rapidly changing ambience, technological advances, whole gamut of safety laws, safety policy and it's designing and their meticulous implementation.

Course Objectives:

- To understand Industrial hazards and Safety requirements with norms
- To learn the basics of Safety performance planning
- To know the means of accident prevention
- To understand the impact of industrialization on environment
- To know the diversified industrial requirements of safety and security

Course Outcomes:

On completion of the course, learner will be able to–

- Formulate the plan for Safety performance
- Formulate the action plan for accidents and hazards
- Follow the safety and security norms in the industry
- Consider critically the environmental issues of Industrialization

Course Contents:

1. Introduction: Elements of safety programming, safety management, Upgrading developmental programmers: safety procedures and performance measures, education, training and development in safety.

2. Safety Performance Planning

Safety Performance: An overview of an accident, It is an accident, injury or incident, The safety professional, Occupational health and industrial hygiene. Understanding the risk: Emergency preparedness and response, prevention of accidents involving hazardous substances.

3. Accident Prevention

What is accident prevention?, Maintenance and Inspection, Monitoring Techniques, General Accident Prevention, Safety Education and Training.

4. Safety Organization

Basic Elements of Organized Safety, Duties of Safety Officer, Safe work Practices, Safety Sampling and Inspection, Job Safety Analysis(JSA), Safety Survey, On- site and Off-site Emergency Plan, Reporting of Accidents and Dangerous Occurrences.

5. Environment

Introduction, Work Environment, Remedy, pollution of Marine Environment and Prevention, Basic Environmental Protection Procedures, Protection of Environment in Global Scenario, Greenhouse Gases, Climate Change Impacts, GHG Mitigation Options, Sinks and Barriers,

6. Industrial Security(Industry wise)

General security Systems in Factories, Activation Security, Computer Security, Banking Security, V.I.P. Security, Women Security, Event Security, Security in Open Environments.

Books:

1. Basudev Panda ,“Industrial Safety, Health Environment and Security”,Laxmi Publications, ISBN-10: 9381159432, 13: 978-9381159439
2. L.M. Deshmukh, “Industrial Safety Management”, TMH , ISBN: 9780070617681

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – V: Emotional Intelligence

This Emotional Intelligence (EI) training course will focus on the five core competencies of emotional intelligence: self-awareness, self-regulation, motivation, empathy and interpersonal skills. Participants will learn to develop and implement these to enhance their relationships in work and life by increasing their understanding of social and emotional behaviors, and learning how to adapt and manage their responses to particular situations. Various models of emotional intelligence will be covered.

Course Objectives:

- To develop an awareness of EI models
- To recognize the benefits of EI
- To understand how you use emotion to facilitate thought and behavior
- To know and utilize the difference between reaction and considered response

Course Outcomes:

On completion of the course, learner will be able to–

- Expand your knowledge of emotional patterns in yourself and others
- Discover how you can manage your emotions, and positively influence yourself and others
- Build more effective relationships with people at work and at home
- Positively influence and motivate colleagues, team members, managers
- Increase the leadership effectiveness by creating an atmosphere that engages others

Course Contents:

1. **Introduction to Emotional Intelligence (EI) :** Emotional Intelligence and various EI models, The EQ competencies of self-awareness, self-regulation, motivation, empathy, and interpersonal skills, Understand EQ and its importance in life and the workplace
2. **Know and manage your emotions:** emotions, The different levels of emotional awareness, Increase your emotional knowledge of yourself, Recognize 'negative' and 'positive' emotions. The relationship between emotions, thought and behavior, Discover the importance of values, The impact of not managing and processing 'negative' emotions, Techniques to manage your emotions in challenging situations
3. **Recognize emotions in others :**The universality of emotional expression, Learn tools to enhance your ability to recognize and appropriately respond to others' emotions, Perceiving emotions accurately in others to build empathy
4. **Relate to others**: Applying EI in the workplace, the role of empathy and trust in relationships, Increase your ability to create effective working relationships with others (peers, subordinates, managers, clients, Find out how to deal with conflict, Tools to lead, motivate others and create a high performing team.

Books:

1. Daniel Goleman," Emotional Intelligence – Why It Matters More Than IQ," , Bantam Books, ISBN-10: 055338371X13: 978-0553383713
2. Steven Stein , "The EQ Edge" , Jossey-Bass, ISBN : 978-0-470-68161-9
3. Drew Bird , "The Leader's Guide to Emotional Intelligence" , ISBN: 9781535176002

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
410249: Audit Course 5
410257: Audit Course 6
AC5 – VI & AC6-VI: MOOC-Learn New Skill

Home

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:

On completion of the course, learner will acquire additional knowledge and skill.

About Course:

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you're interested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWYAM, NPTEL, edx or similar ones can help.

World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhances active learning for improving lifelong learning skills by providing easy access to global resources.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.

This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.
The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

Guidelines:

Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners.

References:

1. https://swayam.gov.in/
2. https://onlinecourses.nptel.ac.in/
3. https://www.edx.org

SEMESTER
II

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410250: Machine Learning

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 207003- Engineering Mathematics III

Companion Course: 410254- Laboratory Practice III

Course Objectives:

- To understand human learning aspects and relate it with machine learning concepts.
- To understand nature of the problem and apply machine learning algorithm.
- To find optimized solution for given problem.

Course Outcomes:

On completion of the course, student will be able to–

- Distinguish different learning based applications
- Apply different preprocessing methods to prepare training data set for machine learning.
- Design and implement supervised and unsupervised machine learning algorithm.
- Implement different learning models
- Learn Meta classifiers and deep learning concepts

Course Contents

Unit I	Introduction to Machine learning	08 Hours

Classic and adaptive machines, Machine learning matters, Beyond machine learning-deep learning and bio inspired adaptive systems, Machine learning and Big data.

Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches, Elements of information theory.

Unit II	Feature Selection	08 Hours

Scikit- learn Dataset, Creating training and test sets, managing categorical data, Managing missing features, Data scaling and normalization, Feature selection and Filtering, Principle Component Analysis(PCA)-non negative matrix factorization, Sparse PCA, Kernel PCA. Atom Extraction and Dictionary Learning.

Unit III	Regression	08 Hours

Linear regression- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Ridge, Lasso and ElasticNet, Robust regression with random sample consensus, Polynomial regression, Isotonic regression,

Logistic regression-Linear classification, Logistic regression, Implementation and Optimizations, Stochastic gradient descendent algorithms, Finding the optimal hyper-parameters through grid search, Classification metric, ROC Curve.

Unit IV	Naïve Bayes and Support Vector Machine	08 Hours

Bayes' Theorom, Naïve Bayes' Classifiers, Naïve Bayes in Scikit- learn- Bernoulli Naïve Bayes, Multinomial Naïve Bayes, and Gaussian Naïve Bayes.

Support Vector Machine(SVM)- Linear Support Vector Machines, Scikit- learn implementation- Linear Classification, Kernel based classification, Non- linear Examples. Controlled Support Vector Machines, Support Vector Regression.

Unit V	Decision Trees and Ensemble Learning	08 Hours

Decision Trees- Impurity measures, Feature Importance. Decision Tree Classification with Scikit-learn, Ensemble Learning-Random Forest, AdaBoost, Gradient Tree Boosting, Voting Classifier.

Clustering Fundamentals- Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness, Adjusted Rand Index.

Introduction to Meta Classifier: Concepts of Weak and eager learner, Ensemble methods, Bagging, Boosting, Random Forests.

Unit VI	Clustering Techniques	08 Hours

Hierarchical Clustering, Expectation maximization clustering, Agglomerative Clustering-Dendrograms, Agglomerative clustering in Scikit- learn, Connectivity Constraints.

Introduction to Recommendation Systems- Naïve User based systems, Content based Systems, Model free collaborative filtering-singular value decomposition, alternating least squares.

Fundamentals of Deep Networks-Defining Deep learning, common architectural principles of deep networks, building blocks of deep networks.

Books:

Text:

1. Giuseppe Bonaccorso, "Machine Learning Algorithms", Packt Publishing Limited, ISBN-10: 1785889621, ISBN-13: 978-1785889622
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioners Approach", O'REILLY, SPD, ISBN: 978-93-5213-604-9, 2017 Edition 1st.

References:

1. Ethem Alpaydin, " Introduction to Machine Learning", PHI 2nd Edition-2013, ISBN 978-0-262-01243-0
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, Edition 2012, *ISBN*-10: 1107422221; ISBN-13: 978-1107422223
3. Tom Mitchell "Machine Learning" McGraw Hill Publication, ISBN :0070428077 9780070428072
4. Nikhil Buduma, "Fundamentals of Deep Learning", O'REILLY publication, second edition 2017, ISBN: 1491925612

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410251: Information and Cyber Security

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks

Companion Course: 410254: Laboratory Practice III

Course Objectives:

- To offer an understanding of principle concepts, central topics and basic approaches in information and cyber security.
- To know the basics of cryptography.
- To acquire knowledge of standard algorithms and protocols employed to provide confidentiality, integrity and authenticity.
- To enhance awareness about Personally Identifiable Information (PII), Information Management, cyber forensics.

Course Outcomes:

On completion of the course, student will be able to–

- Gauge the security protections and limitations provided by today's technology.
- Identify information security and cyber security threats.
- Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.
- Build appropriate security solutions against cyber-attacks.

Course Contents

Unit I	Security Basics	08 Hours

Introduction, Elements of Information Security, Security Policy, Techniques, Steps, Categories, Operational Model of Network Security, Basic Terminologies in Network Security. Threats and Vulnerability, Difference between Security and Privacy.

Unit II	Data Encryption Techniques And Standards	08 Hours

Introduction, Encryption Methods: Symmetric, Asymmetric, Cryptography, Substitution Ciphers. Transposition Ciphers, Stenography applications and limitations, Block Ciphers and methods of operations, Feistal Cipher, Data Encryption Standard (DES), Triple DES, DES Design Criteria, Weak Keys in DES Algorithms, Advance Encryption Standard (AES).

Unit III	Public Key And Management	08 Hours

Public Key Cryptography, RSA Algorithm: Working, Key length, Security, Key Distribution, Deffie-Hellman Key Exchange, Elliptic Curve: Arithmetic, Cryptography, Security, Authentication methods, Message Digest, Kerberos, X.509 Authentication service.

Digital Signatures: Implementation, Algorithms, Standards (DSS), Authentication Protocol.

Unit IV	Security Requirements	08 Hours

Home

IP Security: Introduction, Architecture, IPV6, IPv4, IPSec protocols, and Operations, AH Protocol, ESP Protocol, ISAKMP Protocol, Oakkey determination Protocol, VPN. WEB Security: Introduction, Secure Socket Layer (SSL), SSL Session and Connection, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol. Electronic Mail Security: Introduction, Pretty Good Privacy, MIME, S/MIME, Comparison. Secure Electronic Transaction (SET).

Unit V	Firewall And Intrusion	08 Hours

Introduction, Computer Intrusions. Firewall Introduction, Characteristics and types, Benefits and limitations. Firewall architecture, Trusted Systems, Access Control. Intrusion detection, IDS: Need, Methods, Types of IDS, Password Management, Limitations and Challenges.

Unit VI	Confidentiality And Cyber Forensic	08 Hours

Introduction to Personally Identifiable Information (PII), Cyber Stalking, PII impact levels with examples Cyber Stalking, Cybercrime, PII Confidentiality Safeguards, Information Protection Law: Indian Perspective.

Books:

Text:

1. Bernard Menezes, “Network Security and Cryptography”, Cengage Learning India, 2014, ISBN No.: 8131513491
2. Nina Godbole, Sunit Belapure, “Cyber Security”, Wiley India, 2014, ISBN No.: 978-81-345-2179-1

References:

1. Eoghan Casey, “Digital Evidence and Computer Crime Forensic Science, Computers and the Internet”, ELSEVIER, 2011, ISBN 978-0-12-374268-1
2. Atul Kahate, “Cryptography and Network Security”, Mc Graw Hill Publication, 2nd Edition, 2008, ISBN : 978-0-07-064823-4
3. William Stallings, “Cryptography and network security principles and practices”, Pearson, 6th Edition, ISBN : 978-93-325-1877-3
4. Forouzan, “Cryptography and Network Security (SIE)”, Mc Graw Hill, ISBN, 007070208X, 9780070702080
5. Dr. Nilakshi Jain-Digital Forensic: The Fascinating World of Digital Evidences-Wiley India-ISBN: 9788126565740

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective III
410252(A): Advanced Digital Signal Processing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 410244(A)Digital Signal Processing

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To study the parametric methods for power spectrum estimation.
- To study adaptive filtering techniques and applications of adaptive filtering.
- To learn and understand Multi-rate DSP and applications
- To explore appropriate transforms
- Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech
- Acquire knowledge about different methods used for speech coding and understand various applications of speech processing
- Learn and understand basics of Image Processing and various image filters with its applications

Course Outcomes:

On completion of the course, student will be able to–

- Understand and apply different transforms for the design of DT/Digital systems
- Explore the knowledge of adaptive filtering and Multi-rate DSP
- Design DT systems in the field/area of adaptive filtering, spectral estimation and multi-rate DSP
- Explore use of DCT and WT in speech and image processing
- Develop algorithms in the field of speech , image processing and other DSP applications

Course Contents

Unit I	DFT and Applications	08 Hours

DFT and Applications – Linear filtering, spectral leakage, Spectral resolution and selection of Window Length, Frequency analysis, 2-D DFT, applications in Image and Speech Processing

Unit II	Adaptive FIR and IIR filter Design	08 Hours

Adaptive FIR and IIR filter Design – DT Filters, FIR and IIR filters, Adaptive FIR Filter design: Steepest descent and Newton method, LMS method, Applications, Adaptive IIR Filter design: Pade Approximation, Least square design, Applications

Unit III	Multi-rate DSP and applications	08 Hours

Multi-rate DSP and applications – Decimation, Interpolation, sampling rate conversion, polyphone filter structures, multistage filter design, applications

Unit IV	Spectral Estimation	08 Hours

Home

Spectral Estimation – Estimation of density spectrum, Nonparametric method, Parametric method, Evaluation ,DCT and WT – DCT and KL transform, STFT, WT, Harr Wavelet and Dubecheis Wavelet, Applications of DCT and WT.

Unit V	Speech processing	08 Hours

Speech processing - Speech coding: Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding, Harmonic Coding, Vector Quantization based Coders. Fundamentals of Speech recognition, Speech segmentation, Text-to-speech conversion, speech enhancement, Speaker Verification, Applications.

Unit VI	Image Processing	08 Hours

Image Processing – Image as 2D signal and image enhancement techniques, filter design: low pass, highpass and bandpass for image smoothing and edge detection, Optimum linear filter and order statistic filter, Examples – Wiener and Median filters, Applications

Books:

Text:

1. J. G. Proakis, D. G. Manolakis, " Digital Signal Processing: Principles, Algorithms, and Applications," Prentice Hall, 2007, 4th edition, ISBN: 10: 0131873741
2. Dr. Shaila D. Apate , " Advanced Digital Signal Processing," Wiley Publ., 2013, *ISBN*-10: 8126541245
3. S. K. Mitra, "Digital Signal Processing : A Computer Based Approach", McGraw Hill Higher Education, 2006, 3rd edition, *ISBN*-10: 0070429537
4. Rabiner and Juang, "Fundamentals of Speech Recognition", Prentice Hall, 1994, ISBN:0-13-015157-2 .
5. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing and Analysis", Pearson Education, 3d Ed., 2007, ISBN: 81-7808-629-8

References:

1. Chanda, Muzumdar, "Digital Image Processing and Analysis," Estern Economy Edition, PHI, 2nd Ed., ISBN: 978-81-203-4096-*1*
2. TarunRawat, "Digital Signal Processing", Oxford University Press, 2015, ISBN-10: 0198062281
3. Roberto Crist, "Modern Digital Signal Processing," Thomson Brooks/Cole 2004, ISBN:978-93-80026-55-8.
4. Nelson Morgan and Ben Gold, " Speech and Audio Signal Processing: Processing and Perception Speech and Music", 1999, John Wiley and Sons, ISBN: 0387951547
5. Raghuveer. M. Rao, AjitS.Bopardikar, "Wavelet Transforms: Introduction to Theory and applications," Pearson Education, Asia, 2000.Dale Grover and John R. (Jack) Deller, "Digital Signal Processing and the Microcontroller", Prentice Hall, ISBN:0-13-754920-2

Home

Savitribai Phule Pune University

Fourth Year of Computer Engineering (2015 Course)

Elective III

410252(B): Compilers

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: Theory of Computation(310241), 310251-Systems Programming and Operating System

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To introduce process of compilation
- To introduce complier writing tools
- To address issues in code generation and optimization

Course Outcomes:

On completion of the course, student will be able to–

- Design and implement a lexical analyzer and a syntax analyzer
- Specify appropriate translations to generate intermediate code for the given programming language construct
- Compare and contrast different storage management schemes
- Identify sources for code optimization

Course Contents

Unit I	Notion and Concepts	08 Hours

Introduction to compilers Design issues, passes, phases, symbol table Preliminaries Memory management, Operating system support for compiler, Lexical Analysis Tokens, Regular Expressions, Process of Lexical analysis, Block Schematic, Automatic construction of lexical analyzer using LEX, LEX features and specification.

Unit II	Parsing	08 Hours

Syntax Analysis CFG, top-down and bottom-up parsers, RDP, Predictive parser, SLR, LR(1), LALR parsers, using ambiguous grammar, Error detection and recovery, automatic construction of parsers using YACC, Introduction to Semantic analysis, Need of semantic analysis, type checking and type conversion.

Unit III	Syntax Translation Schemes	08 Hours

Home

Syntax Directed Translation - Attribute grammar, S and L attributed grammar, bottom up and top down evaluations of S and L attributed grammar, Syntax directed translation scheme, Intermediate code - need, types: Syntax Trees, DAG, Three-Address codes: Quadruples, Triples and Indirect Triples, Intermediate code generation of declaration statement and assignment statement.

Unit IV	Run-time Storage Management	08 Hours

Storage Management – Static, Stack and Heap, Activation Record, static and control links, parameter passing, return value, passing array and variable number of arguments, Static and Dynamic scope, Dangling Pointers, translation of control structures – if, if-else statement, Switch-case, while, do -while statements, for, nested blocks, display mechanism, array assignment, pointers, function call and return. Translation of OO constructs: Class, members and Methods.

Unit V	Code Generation	08 Hours

Code Generation - Issues in code generation, basic blocks, flow graphs, DAG representation of basic blocks, Target machine description, peephole optimization, Register allocation and Assignment, Simple code generator, Code generation from labeled tree, Concept of code generator.

Unit VI	Code Optimization	08 Hours

Need for Optimization, local, global and loop optimization, Optimizing transformations, compile time evaluation, common sub-expression elimination, variable propagation, code movement, strength reduction, dead code elimination, DAG based local optimization, Introduction to global data flow analysis, Data flow equations and iterative data flow analysis.

Books:

Text:

1. V Aho, R Sethi, J D Ullman, “Compilers: Principles, Techniques, and Tools", Pearson Edition, ISBN 81-7758-590-8
2. Dick Grune, Bal, Jacobs, Langendoen, “ Modern Compiler Design”, Wiley, ISBN 81-265-0418-8

References:

1. Anthony J. Dos Reis, “Compiler Construction Using Java”, JavaCC and Yacc Wiley, ISBN 978-0-470-94959-7
2. K Muneeswaran, “Compiler Design", Oxford University press, ISBN 0-19-806664-3
3. J R Levin, T Mason, D Brown, “Lex and Yacc", O'Reilly, 2000 ISBN 81-7366-061-X

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective III
410252(C): Embedded and Real Time Operating Systems

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310251-Systems Programming and Operating System

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To understand a typical embedded system and its constituents
- To learn the selection process of processor and memory for the embedded systems
- To learn communication buses and protocols used in the embedded and real-time systems
- To understand real-time operating system (RTOS) and the types of RTOS
- To learn various approaches to real-time scheduling
- To learn software development process and tools for RTOS applications

Course Outcomes:

On completion of the course, student will be able to–

- Recognize and classify embedded and real-time systems
- Explain communication bus protocols used for embedded and real-time systems
- Classify and exemplify scheduling algorithms
- Apply software development process to a given RTOS application
- Design a given RTOS based application

Course Contents

Unit I	Embedded Systems	08 Hours

Introduction to Embedded systems, Characteristics, Challenges, Processors in Embedded systems, hardware Unit s and devices in an embedded system – Power source, memory, real-time clocks, timers, reset circuits, watchdog-timer reset, Input-output ports, buses and interfaces, ADC, DAC, LCD, LED, Keypad, pulse dialer, modem, transceivers, embedded software, software are tools for designing an embedded system.

Unit II	Embedded System On Chip (SOC)	08 Hours

Embedded SOC, ASIC, IP core, ASIP, ASSP, examples of embedded systems. Advanced architectures/processors for embedded systems- ARM, SHARC, DSP, Superscalar Units. Processor organization, Memory organization, Performance metrics for a processor, memory map and addresses, Processor selection and memory selection for real-time applications.

Networked embedded systems- I2C, CAN, USB, Fire wire. Internet enabled systems- TCP, IP, UDP. Wireless and mobile system Protocols- IrDA, Bluetooth, 802.11, ZigBee.

Unit III	I/O Communication	08 Hours

Devices and communication buses: Types of I/O communication, types of serial communication, Serial protocols, Devices and buses- RS-232C, RS-485, HDLC, SPI, SCI, SI, SDIO. Parallel ports and interfacing. Parallel device protocols: ISA, PCI, PCI/X, ARM bus, Wireless devices.

Unit IV	Real Time Operating System	08 Hours

Home

Introduction to real-time operating systems. Hard versus soft real-time systems and their timing constraints. Temporal parameters of real-time process: Fixed, Jittered and sporadic release times, execution time. Types of real-time tasks, Precedence constraints and data dependency among real-time tasks, other types of dependencies for real-time tasks. Functional parameters and Resource parameters of real-time process, Real-time applications: Guidance and control, Signal processing, Multimedia, real-time databases.

Real-time task and task states, task and data. Approaches to real-time scheduling: clock driver, weighted round-robin, priority-driven- Fixed priority and dynamic priority algorithms –Rate Monotonic (RM), Earliest-Deadline-First (EDF), Latest-Release-Time (LRT), Least-Slack-Time-First (LST). Static and Dynamic systems, on-line and off-line scheduling, Scheduling a-periodic and sporadic real-time tasks.

Unit V	Inter-process communication	08 Hours

Resources and resource access control-Assumption on resources and their usage, Enforcing mutual exclusion and critical sections, resource conflicts and blocking, Effects of resource contention and resource access control - priority inversion, priority inheritance.

Inter-process communication-semaphores, message queues, mailboxes and pipes. Other RTOS services-Timer function, events, Interrupts - enabling and disabling interrupts, saving and restoring context, interrupt latency, shared data problem while handling interrupts. Interrupt routines in an RTOS environment.

Unit VI	Multiprocessor Scheduling	08Hours

Multiprocessor Scheduling, resource access control and synchronization in Real-time Operating system. Real-time communication: Model, priority-based service disciplines for switched networks, weighted round-robin service disciplines, Medium access-control protocols for broadcast networks, internet and resource reservation protocols, real-time protocols. Software development process for embedded system: Requirements engineering, Architecture and design of an embedded system, Implementation aspects in an embedded system, estimation modeling in embedded software. Validation and debugging of embedded systems. Embedded software development tools. Debugging techniques. Real-time operating systems: Capabilities of commercial real-time operating systems, QNX/Neutrino, Microc/OS-II, VxWorks, Windows CE and RTLinux.

Books:

Text:

1. Raj Kamal, "Embedded Systems: Architecture, programming and Design", 2nd Edition, McGraw-Hill, ISBN: 13: 9780070151253
2. Jane W. S. Liu, "Real-Time Systems", Pearson Education, ISBN: 10: 0130996513
1. David E. Simon, "An Embedded Software Primer", Pearson Education, ISBN: :8177581546

References:

1. Sriram V. Iyer, Pankaj Gupta, "Embedded Real-time Systems Programming", Tata McGraw-Hill, ISBN: 13: 9780070482845
2. Dr. K. V. K. K. Prasad, "Embedded Real-Time Systems: Concepts: Design and Programming", Black Book, Dreamtech Press, ISBN: 10: 8177224611,13: 9788177224610

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective III
410252(D): Soft Computing and Optimization Algorithms

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310250-Design and Analysis of Algorithm

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To know the basics behind the Design and development intelligent systems in the framework of soft computing
- To acquire knowledge of Artificial Neural Networks Fuzzy sets, Fuzzy Logic, Evolutionary computing and swarm intelligence
- To explore the applications of soft computing
- To understand the need of optimization

Course Outcomes:

On completion of the course, student will be able to–

- Apply soft computing methodologies, including artificial neural networks, fuzzy sets, fuzzy logic, fuzzy inference systems and genetic algorithms
- Design and development of certain scientific and commercial application using computational neural network models, fuzzy models, fuzzy clustering applications and genetic algorithms in specified applications.

Course Contents

Unit I	Introduction	08 Hours

Introduction, soft computing vs. hard computing, various types of soft computing techniques, and applications of soft computing. Basic tools of soft computing – Fuzzy logic, neural network, evolutionary computing. Introduction: Neural networks, application scope of neural networks, fuzzy logic, genetic algorithm, and hybrid systems.

Unit II	Fuzzy Sets and Logic	08 Hours

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications and Defuzzifications.

Unit III	Fuzzy Systems	08 Hours

Fuzzy Controller, Fuzzy rule base and approximate reasoning: truth values and tables in fuzzy logic, fuzzy propositions formation of rules, decomposition of compound rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference system, fuzzy expert systems.

Unit IV	Evolutionary Computing	08 Hours

Home

Basic Evolutionary Processes, EV : A Simple Evolutionary System, Evolutionary Systems as Problem Solvers, A Historical Perspective, Canonical Evolutionary Algorithms - Evolutionary Programming, Evolution Strategies, A Unified View of Simple EAs- A Common Framework, Population Size.

Unit V	Genetic Algorithm	08 Hours

Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Traditional algorithm vs genetic algorithm, simple GA, general genetic algorithm, schema theorem, Classification of genetic algorithm, Holland classifier systems, genetic programming, applications of genetic algorithm, Convergence of GA. Applications and advances in GA, Differences and similarities between GA and other traditional method, applications.

Unit VI	Swarm Intelligence	08 Hours

Swarm intelligence , Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO)- Formulations, Pseudo-code. Applications of PSO and ACO.

Books:

Text:

1. S.N. Sivanandam- “Principles of Soft Computing”, Wiley India- ISBN- 9788126527410
2. S. Rajsekaran and G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications” , Prentice Hall of India, ISBN: 0451211243
3. J S R Jang, CT Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing” , PHI PVT LTD, ISBN 0-13-261066-3.
4. De Jong , “Evolutionary Computation: A Unified Approach”, Cambridge (Massachusetts): MIT Press. ISBN: 0-262-04194-4. 2006
5. Maurice Clerc, “Particle Swarm Optimization”, ISTE, Print ISBN:9781905209040 |Online ISBN:9780470612163 |DOI:10.1002/9780470612163

References:

1. Andries P. Engelbrecht, “Computational Intelligence: An Introduction”, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0
2. N.P.Padhy, “Artificial Intelligence and Intelligent Systems” Oxford University Press, ISBN 10: 0195671546
3. Siman Haykin, “Neural Networks”, Prentice Hall of India, ISBN: 0-7923-9475-5
4. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” , Wiley India, ISBN: 978-0-470-74376-8
5. Eiben and Smith, “Introduction to Evolutionary Computation", Springer, ISBN-10: 3642072852

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective IV
410253(A): Software Defined Networks

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To understand the challenges of the traditional networks and evolution of next generation networks.
- To gain conceptual understanding of Software Defined Networking (SDN) and its role in Data Center.
- To understand role of Open Flow protocol and SDN Controllers.
- To study industrial deployment use-cases of SDN
- To Understand the Network Functions Virtualization and SDN.

Course Outcomes:

On completion of the course, student will be able to–

- Interpret the need of Software Defined Networking solutions.
- Analyze different methodologies for sustainable Software Defined Networking solutions.
- Select best practices for design, deploy and troubleshoot of next generation networks.
- Develop programmability of network elements.
- Demonstrate virtualization and SDN Controllers using OpenFlow protocol

Course Contents

Unit I	Introduction to Software Defined Networking (SDN)	08 Hours

Challenges of traditional networks, Traditional Switch Architecture - Control, Data and management Planes, Introduction to SDN, Need of SDN, History of SDN, Fundamental characteristics of SDN (Plane Separation, Simplified Device and Centralized control, Network Automation and Virtualization, and Openness), SDN Operation/Architecture, SDN API's (Northbound API's, Southbound API's, East/West API's), ONF, SDN Devices and SDN Applications.

Unit II	Open Flow	08 Hours

Home

OpenFlow Overview, The OpenFlow Switch, The OpenFlow Controller, ,OpenFlow Ports, Message Types, Pipeline Processing, Flow Tables, Matching, Instructions, Action Set and List, OpenFlow Protocol, Proactive and Reactive Flow, Timers, OpenFlow Limitations, OpenFlow Advantages and Disadvantages, Open v Switch Features

Unit III	SDN Controllers	08 Hours

SDN OpenFlow Controllers: Open Source Controllers - NOX, POX, Beacon, Maestro, Floodlight, Ryu and Open Daylight, Applicability of OpenFlow protocol in SDN Controllers, Mininet, and implementing software-defined network (SDN) based firewall.

Unit IV	SDN in Data Centre	08 Hours

Data Center Definition, Data Center Demands (Adding, Moving, Deleting Resources, Failure Recovery, Multitenancy, Traffic Engineering and Path Efficiency), Tunneling Technologies for the Data Center, SDN Use Cases in the Data Center, Comparison of Open SDN, Overlays, and APIs, Real-World Data Center Implementations.

Unit V	Network Functions Virtualization (NFV)	08 Hours

Definition of NFV, SDN Vs NFV, In-line network functions, Benefits of Network Functions Virtualization, Challenges for Network Functions Virtualization, Leading NFV Vendors, Comparison of NFV and NV.

Unit VI	SDN Use Cases	08 Hours

Wide Area Networks, Service Provider and Carrier Networks, Campus Networks, Hospitality Networks, Mobile Networks, Optical Networks, SDN vs P2P/Overlay Networks.

Books:

Text:

1. Paul Goransson and Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, 2014, ISBN: 9780124166752, 9780124166844.
2. Siamak Azodolmolky, “Software Defined Networking with Open Flow, Packt Publishing, 2013, ISBN: 9781849698726
3. Thomas D. Nadeau, Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”, 2013, ISBN : 10:1-4493-4230-2, 978-1-4493-4230-2

References:

1. Vivek Tiwari, “SDN and OpenFlow for Beginners”, Digital Services, 2013, ISBN: 10: 1-940686-00-8, 13: 978-1-940686-00-4
2. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, CRC Press, 2014, ISBN: 10: 1466572094
3. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective IV
410253(B): Human Computer Interface

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210251-Computer Graphics

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To design, implement and evaluate effective and usable Human Computer Interfaces.
- To describe and apply core theories, models and methodologies from the field of HCI.
- Learn a variety of methods for evaluating the quality of a user interface
- To implement simple graphical user interfaces based on principles of HCI.

Course Outcomes:

On completion of the course, student will be able to–

- Evaluate the basics of human and computational abilities and limitations.
- Inculcate basic theory, tools and techniques in HCI.
- Apply the fundamental aspects of designing and evaluating interfaces.
- Apply appropriate HCI techniques to design systems that are usable by people

Course Contents

Unit I	Foundations of Human–Computer Interaction	08 Hours

What is HCI – design, models, evaluation, Need to understand people, computers and methods. Basic human abilities - vision, hearing, touch, memory.

Computers – speed, interfaces, widgets, and effects on interaction. Humans – Memory, Attention Span, Visual Perception, psychology, ergonomics. Understanding Users.

Methods for evaluation of interfaces with users: goals of evaluation, approaches, ethics, introspection, extracting the conceptual model, direct observation, constructive interaction, interviews and questionnaires, continuous evaluation via user feedback and field studies, choosing an evaluation method.

Unit II	The Design Process	08 Hours

Interaction Design Basics, Interaction Styles. HCI in the Software Process. HCI design principles and rules: design principles, principles to support usability, golden rules and heuristics, HCI patterns, design rules, HCI design standards. Direct Manipulation - Overview, Scope, Applications. Universal Design, User-centered design, task analysis/GOMS, Graphic Design

Unit III	Implementation	08 Hours

Home

Implementation Tools, Technology and change designing for the Web, designing for portable devices. Handling errors and Designing Help. Prototyping and UI Software.

Unit IV	**Evaluation and User Support**	**08 Hours**

Evaluation of User Interfaces. Web Browsers - Fonts, Color Palette, Color Depth, Resolution, Layout, Size, Orientation. Mobile devices issues – design, limitations, what next. User Support.

Unit V	**Users Models**	**08 Hours**

Predictive Models, Cognitive Models. Interaction with Natural Languages, Next Generation Interface. Socio-organizational Issues and Stakeholder Requirements. Heuristic Evaluation, Evaluation with Cognitive Models, Evaluation with Users.

Unit VI	**Task Models and Dialogs**	**08 Hours**

Task Analysis, DOET (Design of Everyday Things). Design Dialogs Notations, Warnings, and Error messages. Model-based Evaluation. User Testing, Usability Testing, User Acceptance Testing.

Books:

Text:

1. Alan J, Dix. Janet Finlay, Rusell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004, ISBN 81-297-0409-9
2. Jenny Preece, Rogers, Sharp, “Interaction Design-beyond human-computer interaction”, WILEY-INDIA, ISBN 81-265-0393-9

References:

3. Jonathan Lazar, Jinjuan Feng, Harry Hochheiser, “Research Methods in Human-Computer Interaction", Third Edition, Morgan Kaufmann, 2017, ISBN: 9780128053904.
4. Mary Beth Rosson and John M. Carroll, “Usability Engineering: Scenario-Based Development of Human-Computer Interaction”, Morgan Kaufmann, 2001, ISBN-13**:** 978-1558607125

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective IV
410253(C): Cloud Computing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245 Computer Networks

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To understand cloud computing concepts;
- To study various platforms for cloud computing
- To explore the applications based on cloud computing

Course Outcomes:

On completion of the course, student will be able to–

- To install cloud computing environments.
- To develop any one type of cloud
- To explore future trends of cloud computing

Course Contents

Unit I	Basics of Cloud Computing	08 Hours

Overview, Applications, Intranets and the Cloud. Your Organization and Cloud Computing- Benefits, Limitations, Security Concerns. Software as a Service (SaaS)- Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Benefits of Paas Solutions, Disadvantages of PaaS Solutions. Infrastructure as a Service (IaaS)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages, Server Types. Identity as a Service (IDaaS).

Unit II	Data Storage and Security in Cloud	08 Hours

Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo Cloud data stores: Datastore and Simple DB Gautam Shrauf, Cloud Storage-Overview, Cloud Storage Providers. [Anthony T. Velte]3 Securing the Cloud- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Disaster Recovery- Understanding the Threats.

Unit III	Virtualization	08 Hours

Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Types of Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation. Common Standards: The Open Cloud Consortium, Open Virtualization Format, Standards for Application Developers: Browsers (Ajax), Data (XML, JSON), Solution Stacks (LAMP and LAPP),Syndication (Atom, Atom Publishing Protocol, and RSS), Standards for Security.

Unit IV	Amazon Web Services	08 Hours

Home

Services offered by Amazon Hands-on Amazon, EC2 - Configuring a server, Virtual Amazon Cloud, AWS Storage and Content Delivery Identify key AWS storage options Describe Amazon EBS Creating an Elastic Block Store Volume Adding an EBS Volume to an Instance Snap shotting an EBS Volume and Increasing Performance Create an Amazon S3 bucket and manage associated objects. AWS Load Balancing Service Introduction Elastic Load Balancer Creating and Verifying Elastic Load Balancer.

Unit V	Ubiquitous Clouds and the Internet of Things	08 Hours

Cloud Trends in Supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud, Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS), Innovative Applications of the Internet of Things (Smart Buildings and Smart Power Grid, Retailing and Supply-Chain Management, Cyber-Physical System), Online Social and Professional Networking.

Unit VI	Future of Cloud Computing	08 Hours

How the Cloud Will Change Operating Systems, Location-Aware Applications, Intelligent Fabrics, Paints, and More, The Future of Cloud TV, Future of Cloud-Based Smart Devices, Faster Time to Market for Software Applications, Home-Based Cloud Computing, Mobile Cloud, Autonomic Cloud Engine, Multimedia Cloud, Energy Aware Cloud Computing, Jungle Computing. Docker at a Glance: Process Simplification, Broad Support and Adoption, Architecture, Getting the Most from Docker, The Docker Workflow.

Books:

Text:

1. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill.
2. Dr. Kris Jamsa, " Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more" , Wiley Publications, ISBN: 978-0-470-97389-9
3. Gautam Shrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications, Cambridge University Press, *ISBN*: 9780511778476

References:

1. Dr. Kumar Saurabh,"Cloud Computing", Wiley Publication, ISBN10: 8126536039
2. Buyya, "Mastering Cloud Computing", Tata McGraw Hill, ISBN-13: 978-1-25-902995-0,
3. Barrie Sosinsky,"Cloud Computing", Wiley India, ISBN: 978-0-470-90356-8
4. Kailash Jayaswal, "Cloud computing", Black Book, Dreamtech Press
5. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Pearson, 1st Edition, ISBN :978 9332535923, 9332535922
4. Tim Mather, Subra K, Shahid L.,Cloud Security and Privacy, Oreilly, ISBN-13 978-81-8404-815-5

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective IV
410253(D): Open Elective

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Companion Course: 410255-Laboratory Practice IV

The open elective included, so as to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time.

Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons.

With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies.

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410254:Laboratory Practice III

Teaching Scheme:	Credit	Examination Scheme:
Practical : 04 Hours/Week	02	Term Work: 50 Marks Practical: 50 Marks

Companion Courses: 410250 and 410251

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the core courses.

About

Laboratory Practice III is for practical hands on for core courses Machine Learning and Information & Cyber Security.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative

Programming Languages: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal may consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Home

Continuous assessment of laboratory work is to be done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed.
- During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising boost to the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Suggested List of Laboratory Assignments& Mini Projects

(any 04 assignments Machine Learning and Information & Cyber Security AND Mini-project per course)

410250: Machine Learning

1. Assignment on Linear Regression:

The following table shows the results of a recently conducted study on the correlation of the number of hours spent driving with the risk of developing acute backache. Find the equation of the best fit line for this data.

Number of hours spent driving (x)	Risk score on a scale of 0-100 (y)
10	95
9	80
2	10
15	50
10	45
16	98
11	38
16	93

2. Assignment on Decision Tree Classifier:

A dataset collected in a cosmetics shop showing details of customers and whether or not they responded to a special offer to buy a new lip-stick is shown in table below. Use this dataset to

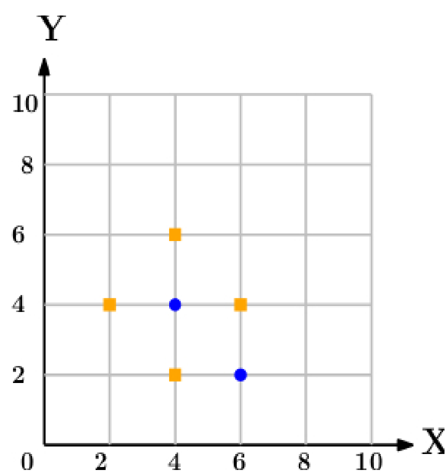
Home

build a decision tree, with Buys as the target variable, to help in buying lip-sticks in the future. Find the root node of decision tree. According to the decision tree you have made from previous training data set, what is the decision for the test data: [Age < 21, Income = Low, Gender = Female, Marital Status = Married]?

ID	Age	Income	Gender	Marital Status	Buys
1	< 21	High	Male	Single	No
2	< 21	High	Male	Married	No
3	21-35	High	Male	Single	Yes
4	>35	Medium	Male	Single	Yes
5	>35	Low	Female	Single	Yes
6	>35	Low	Female	Married	No
7	21-35	Low	Female	Married	Yes
8	< 21	Medium	Male	Single	No
9	<21	Low	Female	Married	Yes
10	> 35	Medium	Female	Single	Yes
11	< 21	Medium	Female	Married	Yes
12	21-35	Medium	Male	Married	Yes
13	21-35	High	Female	Single	Yes
14	> 35	Medium	Male	Married	No

3. Assignment on k-NN Classification:

In the following diagram let blue circles indicate positive examples and orange squares indicate negative examples. We want to use k-NN algorithm for classifying the points. If k=3, find the class of the point (6,6). Extend the same example for Distance-Weighted k-NN and Locally weighted Averaging



4. Assignment on K-Means Clustering:

We have given a collection of 8 points. P1=[0.1,0.6] P2=[0.15,0.71] P3=[0.08,0.9] P4=[0.16, 0.85] P5=[0.2,0.3] P6=[0.25,0.5] P7=[0.24,0.1] P8=[0.3,0.2]. Perform the k-mean clustering with initial centroids as m1=P1 =Cluster#1=C1 and m2=P8=cluster#2=C2. Answer the following

1] Which cluster does P6 belongs to?
2] What is the population of cluster around m2?
3] What is updated value of m1 and m2?

5. Mini-Project 1 on Genetic Algorithm:

Apply the Genetic Algorithm for optimization on a dataset obtained from UCI ML repository. For Example: IRIS Dataset or Travelling Salesman Problem or KDD Dataset

Home

6.	**Mini-Project 2** on SVM: Apply the Support vector machine for classification on a dataset obtained from UCI ML repository. For Example: Fruits Classification or Soil Classification or Leaf Disease Classification
7.	**Mini-Project 3** on PCA: Apply the Principal Component Analysis for feature reduction on any Company Stock Market Dataset
410251:: : Information and Cyber Security	
1.	Implementation of S-DES
2.	Implementation of S-AES
3.	Implementation of Diffie-Hellman key exchange
4.	Implementation of RSA.
5.	Implementation of ECC algorithm.
6.	**Mini Project 1:** SQL Injection attacks and Cross -Site Scripting attacks are the two most common attacks on web application. Develop a new policy based Proxy Agent, which classifies the request as a scripted request or query based request, and then, detects the respective type of attack, if any in the request. It should detect both SQL injection attack as well as the Cross-Site Scripting attacks.
7.	**Mini Project 2:**This task is to demonstrate insecure and secured website. Develop a web site and demonstrate how the contents of the site can be changed by the attackers if it is http based and not secured. You can also add payment gateway and demonstrate how money transactions can be hacked by the hackers. Then support your website having https with SSL and demonstrate how secured website is.

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410255:Laboratory Practice IV

Teaching Scheme:	Credit	Examination Scheme:
Practical : 04 Hours/Week	02	Term Work: 50 Marks Presentation: 50 Marks

Companion Courses: 410252 and 410253

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the elective courses. Enough choice is provided to the learner to choose an elective of one's interest.

Laboratory Practice II is companion lab for elective course III and elective course IV.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative

Programming Languages: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal may consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Continuous assessment of laboratory work is to be done based on overall performance and lab

Home

assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- **It is recommended to conduct examination based on Mini-Project(s) Demonstration and related skill learned.** Team of 2 to 3 students may work on mini-project. During the assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation and software engineering approach followed.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding, effective and efficient implementation and demonstration skills.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Suggested List of Laboratory Assignments & Mini Projects

Recommended / Sample set of assignments and mini projects for reference for four courses offered for Elective I and for four courses offered for Elective II. Respective Student have to complete laboratory work for elective I and II that he/she has opted.

410252: Elective III

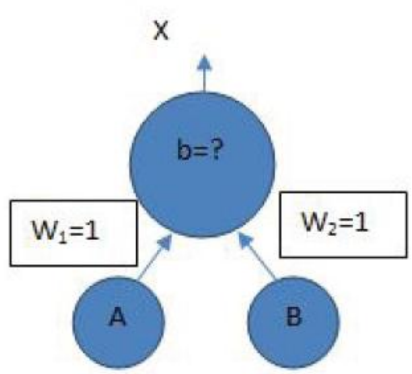
410252 (A) Advanced Digital Signal Processing

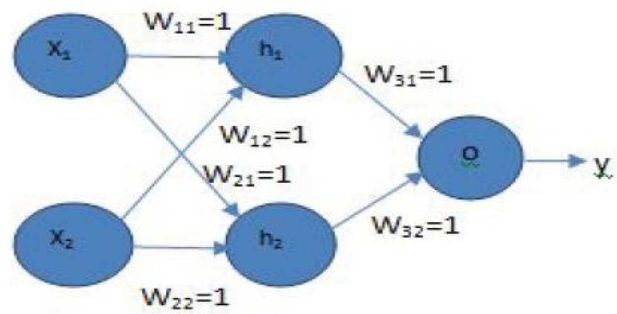
Use -
A] MATLAB or other equivalent software working with speech and image signals/files and for analysis purpose.
B] C++ or JAVA for working with sampled data (n – point data samples of DT/Digital signal)
C] JAVA or other for image processing assignments

1.	Apply 1-D DFT to observe spectral leakage and frequency analysis of different window sequences, plot the frequency spectrums.
2.	Adaptive FIR and IIR filter design: A] Steepest descent and Newton method, LMS method, B] Adaptive IIR Filter design: Pade Approximation, Least square design
3.	Power spectrum estimation and analysis: Take a speech signal and perform A] Non parametric method: DFT and window sequences B] Parametric methods: AR model parameters
4.	Multi-rate DSP and applications – Decimation, Interpolation, sampling rate conversion A] Take a speech signal with specified sampling frequency. Decimate by factor D(e.g. factor B] Take a speech signal with specified sampling frequency. Interpolate by factor I(e.g. factor)

Home

	C] Sampling rate conversion by factor of I/D
5.	Write a program to calculate LPC coefficients, reflection coefficients using Levinson Durbin algorithm
6.	Feature Extraction of speech signal A] Using LPC and other methods B] Apply different coding methods: harmonic coding, vector quantization
7.	**Mini-Project 1:** Discrete Cosine Transform (DCT) A] To find DCT of NxN image block B] To plot spectrum of the speech signal using DCT and find the correlation of DCT transformed signal C] Image filtering using DCT : LPF, edge detection D] Image compression using DCT, Image resizing
8.	**Mini-Project 2:** Wavelet Transform (WT) A] To get compression using wavelet decomposition of a signal B] Denoising using wavelet decomposition C] To get compression using wavelet decomposition of a signal (Harr Wavelet) D] To get low-pass filtered and high pass filtered speech signal using Haar wavelet E] Image filtering using WT
9.	**Mini-Project 3:** Image Processing A] Histogram and Equalization B] Image Enhancement Techniques C] Image Filtering: LPF, HPF, Sobel/Prewitt Masks D] Image Smoothing with special filters: Median, Weiner, Homomorphic filters
Course: 410252 (B) Compiler Construction	
1.	Implement a Lexical Analyzer using LEX for a subset of C. Cross check your output with Stanford LEX.
2.	Implement a parser for an expression grammar using YACC and LEX for the subset of C. Cross check your output with Stanford LEX and YACC.
3.	Generate and populate appropriate Symbol Table.
4.	Implementation of Semantic Analysis Operations (like type checking, verification of function parameters, variable declarations and coercions) possibly using an Attributed Translation Grammar.
5.	Implement the front end of a compiler that generates the three address code for a simple language.
6.	A Register Allocation algorithm that translates the given code into one with a fixed number of registers.
7.	Implementation of Instruction Scheduling Algorithm.
8.	Implement Local and Global Code Optimizations such as Common Sub-expression Elimination, Copy Propagation, Dead-Code Elimination, Loop and Basic-Block Optimizations. (Optional)
9.	**Mini-Project 1:** Implement POS tagging for simple sentences written Hindi or any Indian Language
Course: 410252 (C) Embedded and Real Time Operating Systems	
1.	Simulation/ Design, planning and modeling of a Real-Time / Embedded System for- (any one) • Alarm system for elderly people (Fall detection, Heart attack) • Medication machine for patients in ICU • Smart traffic control • Autonomous car • Smart home (sound system, temperature, light)

	• Control of an autonomous quadrocopter (e.g. for surveillance tasks) • Control of a rail station • Video conference system • Washing machine
Course: 410252 (D) Soft Computing and Optimization Algorithms	
1.	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
2.	Implement genetic algorithm for benchmark function (eg. Square, Rosenbrock function etc) Initialize the population from the Standard Normal Distribution. Evaluate the fitness of all its individuals. Then you will do multiple generation of a genetic algorithm. A generation consists of applying selection, crossover, mutation, and replacement. Use: • Tournament selection without replacement with tournament size s • One point crossover with probability Pc • bit-flip mutation with probability Pm • use full replacement strategy
3.	Implement Particle swarm optimization for benchmark function (eg. Square, Rosenbrock function). Initialize the population from the Standard Normal Distribution. Evaluate fitness of all particles. Use : • c1=c2 = 2 • Inertia weight is linearly varied between 0.9 to 0.4. • Global best variation
4.	Implement basic logic gates using Mc-Culoch-Pitts or Hebbnet neural networks
5.	Write a program to find the Boolean function to implement following single layer perceptron. Assume all activation functions to be the threshold function which is 1 for all input values greater than zero and 0, otherwise. 
6.	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
7.	The figure shows a single hidden layer neural network. The weights are initialized to 1's as shown in the diagram and all biases are initialized to 0's. Assume all the neurons have linear activation functions. The neural network is to be trained with stochastic (online) gradient descent. The first training example is [x1=1, x2=0] and the desired output is 1. Design the back-propagation algorithm to find the updated value for W11 after backpropagation. Choose the value that is the closest to the options given below: [learning rate =0.1]

	
8.	**Mini-Project 1** on Genetic Algorithm: Apply the Genetic Algorithm for optimization on a dataset obtained from UCI ML repository. For Example: IRIS Dataset or Travelling Salesman Problem or KDD Dataset
9.	Apply the Particle swarm optimization for Travelling Salesman Problem
10.	**Mini-Project 2** on Fuzzy Logic: Solve Greg Viot's fuzzy cruise controller using MATLAB Fuzzy logic toolbox or Octave or Python.
11.	**Mini-Project 3** on Fuzzy Logic: Solve Air Conditioner Controller using MATLAB Fuzzy logic toolbox or Octave or Python.
410253: Elective III	
Course: 410253 (A) Software Defined Networks	
1.	Phase I:Set up Mininet network emulation environment using Virtual Box and Mininet. Demonstrate the basic commands in Mininet and emulate different custom network topology (Simple, Linear, and Tree).View flow tables.
2.	Phase II:Study open source POX and Floodlight controller. Install controller and run custom topology using remote controller like POX and floodlight controller. Identify inserted flows by the controllers.
3.	Phase III:Create a SDN environment on Mininet and configure a switch to provide a firewall functionality using POX controller. Ref:https://github.com/mininet/openflow-tutorial/wiki/Create- Firewall
4.	Phase IV:Build your own Internet Router using Mininet as an Emulator and POX controller. Write a simple router with a static routing table. The router will receive raw Ethernet frames. It will process the packets just like a real router, and then forward them to the correct outgoing interface. Make sure you receive the Ethernet frame and create the forwarding logic so packets go to the correct interface. Ref:https://github.com/mininet/mininet/wiki/Simple-Router
5.	Phase V: Emulate a Data Center and manage it via a Cloud Network Controller: create a multi-rooted tree-like (Clos) topology in Mininet to emulate a data center. Your second task is to implement specific SDN applications on top of the network controller in order to orchestrate multiple network tenants within a data center environment, in the context of network virtualization and management. Ref: https://opencourses.uoc.gr/courses/pluginfile.php/13576/mod_resource/content/2/exercise5.pdf
Course:410253 (B) Human Computer Interface	
1.	Identify specialized users and related facilities for a selected product / system and make necessary suggestions for its improved accessibility design.

Home

2.	Design user persona for the users of selected product / system.
3.	Conduct a contextual inquiry for selected product / system.
4.	Design an interface prototype for selected product / system.
5.	Evaluate an interface using usability evaluation technique.
Course: 410253 (C) Cloud Computing	
1.	1. Installation and configuration of own Cloud 2. Implementation of Virtualization in Cloud Computing to Learn Virtualization Basics, Benefits of Virtualization in Cloud using Open Source Operating System. 3. Study and implementation of infrastructure as Service using Open Stack. 4. Write a program for Web feed using PHP and HTML. 5. Write a Program to Create, Manage and groups User accounts in own Cloud by Installing Administrative Features. 6. Case study on Amazon EC2 to learn about Amazon EC2,Amazon Elastic Compute Cloud is a central part of Amazon.com's cloud computing platform, Amazon Web Services. How EC2 allows users torrent virtual computers on which to run their own computer applications. 7. Case study on Microsoft azure to learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, forbuilding, deploying and managing applications and services through a global network of Microsoft-managed datacenters. How it work, different services provided by it. 8. Design and develop custom Application (Mini Project) using Salesforce Cloud. 9. Assignment to install and configure Google App Engine. 10. Design an Assignment to retrieve, verify, and store user credentials using Firebase Authentication, the Google App Engine standard environment, and Google Cloud Data store. 11. Creating an Application in SalesForce.com using Apex programming Language. **12.** Design an Assignment based on Working with Mangrasoft Aneka Software.
2.	**Mini-Project 1:** Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open source technologies **without HDFS**. Implement the basic operations may be like to upload and download file on/from cloud in encrypted form.
3.	**Mini-Project 2:** Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open source technologies to implement **with HDFS**. Implement the basic operations may be like to divide the file in segments/blocks and upload/ download file on/from cloud in encrypted form.
Course: 410253 (D) Open Elective	
Suitable set of programming assignments/Mini-projects for open elective Opted.	

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410256:Project Work Stage II

Teaching Scheme:	Credit	Examination Scheme:
Practical : 06 Hours/Week	06	Term Work: 100 Marks Presentation: 50 Marks

Course Objectives:

- To follow SDLC meticulously and meet the objectives of proposed work
- To test rigorously before deployment of system
- To validate the work undertaken
- To consolidate the work as furnished report.

Course Outcomes:

On completion of the course, student will be able to–

- Show evidence of independent investigation
- Critically analyze the results and their interpretation.
- Report and present the original results in an orderly way and placing the open questions in the right perspective.
- Link techniques and results from literature as well as actual research and future research lines with the research.
- Appreciate practical implications and constraints of the specialist subject

Guidelines

In Project Work Stage–II, the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions. The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is the duly certified by the concerned guide and head of the Department/Institute.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6

Home

In addition to credits, it is recommended that there should be audit course in preferably in each semester from second year to supplement their knowledge and skills. Student will be awarded the bachelor‘s degree if he/she earns 190 credits and clears all the audit courses specified in the syllabus. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course's inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level itself. Method of conduction and method of assessment for audit courses are suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself. (Ref- http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction and Assessment(Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini Project
- Hands on experience on specific focused topic

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report

Audit Course 3 Options

AC6- I	Business Intelligence
AC6-II	Gamification
AC6-III	Quantum Computing
AC6-IV	Usability Engineering
AC6-V	Conversational Interfaces
AC6-VI	MOOC- Learn New Skills (Refer Page 48)

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier
http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – I: Business Intelligence

The course aims at examining Business Intelligence (BI) as a broad category of applications and technologies for gathering, storing, analyzing, sharing and providing access to data to help enterprise users make better managerial decisions.

Course Objectives:

- To understand the concept of Business Intelligence
- To know the details of Decision Support System
- To inculcate the concepts of Data Warehousing
- To understand the basics of design and management of BI systems

Course Outcome:

On completion of the course, learner will be able to–

- Apply the concepts of Business Intelligence in real world applications
- Explore and use the data warehousing wherever necessary
- Design and manage practical BI systems

Course Contents:

1.Concepts with Mathematical treatment : Introduction to data, Information and knowledge, Decision Support System, Theory of Operational data and informational data, Introduction to Business Intelligence, Determining BI Cycle, BI Environment and Architecture, Identify BI opportunities, Benefits of BI. Role of Mathematical model in BI, Factors Responsible for successful BI Project, Obstacle to Business Intelligence in an Organization

2. Decision Making Concepts : Concepts of Decision Making, Techniques of Decision Support System (DSS), Development of Decision Support System (DSS), Applications of DSS, Role of Business Intelligence in DSS.

3. Data-Warehouse : Introduction: Data warehouse Modeling, data warehouse design, data-warehouse technology, Distributed data warehouse, and materialized view

4.Data Pre-processing and outliers: Data Analytics life cycle, Discovery, Data preparation, Preprocessing requirements, data cleaning, data integration, data reduction, data transformation, Data discretization, and concept hierarchy generation, Model Planning, Model building, Communicating Results and Findings, Operationalizing, Introduction to OLAP. Real-world Applications, types of outliers, outlier challenges, Outlier detection Methods, Proximity-Based Outlier analysis, Clustering Based Outlier analysis.

5.Designing and managing BI systems : Determining infrastructure requirements, planning for scalability and availability, managing and maintenance of BI systems, managing BI operations or business continuity

Books:

1. R. Sharda, D. Delen, and E. Turban, Business Intelligence and Analytics. Systems for Decision Support,10th Edition. Pearson/Prentice Hall, 2015. ISBN-13: 978-0-13-305090-5, ISBN-10: 0-13-305090-4;

2. Business Process Automation, Sanjay Mohapatra, PHI.

3. Introduction to business Intelligence and data warehousing, IBM, PHI, ISBN: 9788120339279

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – II: Gamification

Gamification is the application of game-design elements and game principles in non-game contexts. Gamification commonly employs game design elements to improve user engagement, organizational productivity, flow, crowd sourcing, employee recruitment and evaluation, ease of use, usefulness of systems, exercise, traffic violations, voter apathy, and more.

Course Objectives:

- To develop problem solving abilities using gamification
- To apply gamifications for Web Applications
- To apply gamifications for Mobile Applications

Course Outcome:

On completion of the course, learner will be able to–

- To write survey on the gamification paradigms.
- To write programs to solve problems using gamification and open source tools.
- To solve problems for multi-core or distributed, concurrent/Parallel environments

Course Contents:

1. **Gaming Foundations:** Introduction, Resetting Behavior, Replaying History, Gaming foundations: Fun Quotient, Evolution by loyalty, status at the wheel, the House always wins.
2. **Developing Thinking:** Re-framing Context, Player Motivation, Case studies for Thinking: Tower of Hanoi.
3. **Opponent Moves in Gamification:** Reclaiming Opposition, Gamed Agencies, Remodeling design, Game Mechanics, Case study of Maze Problem.
4. **Game Design:** Game Mechanics and Dynamics: Feedback and Re-enforcement, Game Mechanics in depth, putting it together, Case study of 8 queens problem.
5. **Advanced tools, techniques and applications:** Gamification case Studies, Coding basic game Mechanics, Instant Gamification Platforms, Mambo.io(Ref:http://mambi.io), Installation and use of BigDoor (Open Source http://bigdoor.com),ngageoint/gamification-server (ref: https://github.com/ngageoint/gamification-server

Books:

1. Mathias Fuchs, Sonia Fizek,Paolo Ruffino, Niklas Schrape, Rethinking Gamification, Meson Press, ISBN (Print): 978-3-95796-000-9 , http://projects.digital-cultures.net/meson-press/files/2014/06/9783957960016-rethinking-gamification.pdf, ISBN (PDF): 978-3-95796-001-6,
2. , Gabe Zechermann, Christopher Cunningham, Gamification Design, Oreilly, ISBN: 978-1-449-39767-8, ftp://ftp.ivacuum.ru/i/WooLF/%B2011%5D%20Gamification%20by%20Design.pdf
3. http://press.etc.cmu.edu/files/MobileMediaLearning-DikkersMartinCoulter-web.pdf

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – III: Quantum Computing

Quantum computation and quantum information is the study of the information processing tasks that can be accomplished using quantum mechanical systems. Sounds pretty simple and obvious, doesn't it? Like many simple but profound ideas it was a long time before anybody thought of doing information processing using quantum mechanical sys- tems. To see why this is the case, we must go back in time and look in turn at each of the fields which have contributed fundamental ideas to quantum computation and quantum information -quantum mechanics, computer science, information theory, and cryptography.

Course Objectives:

- To understand basic concepts of quantum computing
- To learn quantum search algorithms
- To apply quantum information for solving real world problem

Course Outcome:

On completion of the course, learner will be able to–

- design efficient quantum algorithms
- apply quantum algorithms for several basic promise problems
- learn the hidden subgroup problems and their role in quantum computing

Course Contents:

1. **Fundamental concepts:** Introduction and overview, Quantum computation, quantum algorithm, Introduction to quantum mechanics, The postulates of quantum mechanics
2. **Quantum computation:** Quantum circuits, The quantum Fourier transform and its applications, Quantum search algorithms, Quantum computers: physical realization
3. **Quantum information:** Quantum noise and quantum operations, Distance measures for quantum information, Quantum error-correction, mEntropy and information, Quantum information theory

Books:

1. Michael A. Nielsen and Isaac L. Chuang, “Quantum Computation and Quantum Information”, ISBN: 9780521635035.
2. Mikio Nakahara and Tetsuo Ohmi, "Quantum Computing", CRC Press 2008.
3. N. David Mermin, "Quantum Computer Science", Cambridge 2007

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – IV: Usability Engineering

In this course you will have a hands-on experience with usability evaluation and user-centered design. This course will not help to learn how to implement user interfaces, but rather how to design based on the needs of users, which you will determine, and learn how toevaluate your designs rigorously. This help in knowing more about the usability; human computer interaction, the psychological aspects of computing, evaluation.

Course Objectives:

- To understand the human centered design process and usability engineering process and their roles in system design and development.
- To know usability design guidelines, their foundations, assumptions, advantages, and weaknesses
- Understand the user interface based on analysis of human needs and prepare a prototype system

Course Outcome:

On completion of the course, learner will be able to–

- Describe the human centered design process and usability engineering process and their roles in system design and development.
- Discuss usability design guidelines, their foundations, assumptions, advantages, and weaknesses.
- Design a user interface based on analysis of human needs and prepare a prototype system.
- Assess user interfaces using different usability engineering techniques.
- Present the design decisions

Course Contents:

1. Introduction: Usability and Other Considerations, Definition of Usability, Example: Measuring the Usability of Icons, Usability Trade-Offs, Categories of Users and Individual User Differences
2. Usability in Software Development : The Emergence of Usability, Human Computer Interaction, Usability Engineering
3. The usability Engineering Lifecycle: Requirement Analysis, Design, Testing, Development
4. Usability Assessment Methods beyond Testing
5. International User Interfaces

Books:

1. Mary Beth Rosson, John Millar Carroll, “Usability Engineering: Scenario- based Development of Human- Computer Interaction”
2. Jakob Nielsen, “Usability Engineering”
1. Deborah J. Mayhew, “ The usability engineering lifecycle”

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – V: Conversational Interfaces

Effective information security at the enterprise level requires participation, planning, and practice. It is an ongoing effort that requires management and staff to work together from the same script. Fortunately, the information security community has developed a variety of resources, methods, and best practices to help modern enterprises address the challenge. Unfortunately, employing these tools demands a high degree of commitment, understanding, and skill attributes that must be sustained through constant awareness and training.

Course Objectives:

- To understand the basics of conversation
- To know the interactive environments for conversational skills
- To acquaint with the speech to text and text to speech techniques

Course Outcome:

On completion of the course, learner will be able to–

- Develop an effective interface for conversation
- Explore advanced concepts in user interface

Course Contents:

1. **Introduction to Conversational Interface:** Preliminaries, Developing a speech based Conversational Interface, Conversational Interface and devices.
2. **A technology of Conversation:** Introduction, Conversation as Action, The structure of Conversation, The language of Conversation.
3. **Developing a Speech-Based Conversational Interface:** Implementing Text to Speech: Text Analysis, Wave Synthesis, Implementing Speech Recognition: Language Model, Acoustic Model, Decoding. Speech Synthesis Markup Language.
4. **Advanced voice user interface design**

Books:

1. Cathy Pearl, “Designing Voice User Interfaces: Principles of Conversational Experiences”
2. Michael McTear, ZoraidaCallejas, David Griol, “ The Conversational Interface: Talking to Smart Devices”
3. Martin Mitrevski, “Developing Conversational Interfaces for iOS: Add Responsive Voice Control”
4. SriniJanarthanam, “ Hands-On Chatbots and Conversational UI Development: Build chatbots”

Home

Savitribai Phule Pune University
Bachelor of Computer Engineering (2015 Course)
(Total 190 Credit)

First Year		Second Year		Third Year		Forth Year	
Credit =50		**Credit =50**		**Credit =46**		**Credit =44**	
Semester I							
Course Code	**Course**	**Course Code**	**Course**	**Course Code**	**Course**	**Course Code**	**Course**
107001	Engineering Mathematics I	210241	Discrete Mathematics	310241	Theory of Computation	410241	High Performance Computing
107002 / 107009	Engineering Physics / Engineering Chemistry	210242	Digital Electronics and Logic Design	310242	Database Management Systems (DBMS)	410242	Artificial Intelligence and Robotics
102006	Engineering Graphics I	210243	Data Structures and Algorithms	310243	Software Engineering & Project Management	410243	Data Analytics
103004 / 104012	Basic Electrical Engineering /Basic Electronics Engineering	210244	Computer Organization and Architecture	310244	Information Systems & Engineering Economics	410244	Elective I • Digital Signal Processing • Software Architecture and Design • Pervasive and Ubiquitous Computing • Data Mining and Warehousing
101005	Basic Civil and Environmental Engineering	210245	Object Oriented Programming	310245	Computer Networks (CN)	410245	Elective II • Distributed Systems • Software Testing and Quality Assurance • Operations Research • Mobile Communication
110003	Fundamentals of Programming Languages I	210246	Digital Electronics Lab	310246	Skills Development Lab	410246	Laboratory Practice I
111007	Workshop Practice	210247	Data Structures Lab	310247	DBMS Lab	410247	Laboratory Practice II
		210248	Object Oriented Programming Lab	310248	CN Lab	410248	Project Work Stage I
		210249	Soft Skills	310249	Audit Course 3	410249	Audit Course 3
		210250	Audit Course 1				

Home

Semester II

Course Code	Course	Course Code	Course	Course Code	Course	Course Code	Course
107008	Engineering Mathematics II	207003	Engineering Mathematics III	310250	Design & Analysis of Algorithms	410250	Machine Learning
107009 / 107002	Engineering Chemistry / Engineering Physics	210251	Computer Graphics	310251	Systems Programming & Operating System (SP & OS)	410251	Information and Cyber Security
102013	Basic Mechanical Engineering	210252	Advanced Data Structures	310252	Embedded Systems & Internet of Things (ES & IoT)	410252	Elective III Advanced Digital Signal Processing Compilers Embedded and Real Time Operating Systems Soft Computing and Optimization Algorithms
101011	Engineering Mechanics	210253	Microprocessor	310253	Software Modeling and Design	410253	Elective IV Software Defined Networks Human Computer Interface Cloud Computing Open Elective
104012 / 103004	Basic Electronics Engineering / Basic Electrical Engineering	210254	Principles of Programming Languages	310254	Web Technology	410254	Laboratory Practice III
110010	Fundamentals of Programming Languages II	210255	Computer Graphics Lab	310255	Seminar & Technical Communication	410255	Laboratory Practice IV
102014	Engineering Graphics II	210256	Advanced Data Structures Lab	310256	Web Technology Lab	410256	Project Work Stage II
		210257	Microprocessor Lab	310257	SP & OS Lab	410257	Audit Course 3
		210258	Audit Course 2	310258	ES & IoT Lab		
				310259	Audit Course 4		

Home

SAVITRIBAI PHULE PUNE UNIVERSITY

FACULTY OF ENGINEERING

SYLLABUS FOR

B.E. ELECTRICAL ENGINEERING

(2015 course)

WITH EFFECT FROM YEAR 2018-2019

Savitribai Phule Pune University
FACULTY OF ENGINEERING

B.E. Electrical Engineering (2015 Course)
(w.e.f. 2018-2019)

SEMESTER-I

Sr No	Subject Code	Subject Title	Teaching Scheme (Hrs/Week)			Examination Scheme (Marks)					Total Marks	Credit	
						PP							
			TH	PR	TU	In Sem	End Sem	TW	PR	OR		TH / TU	PR + OR
1	403141	Power System Operation and Control	03	02	--	30	70	25	--	25	150	03	01
2	403142	PLC and SCADA Applications	04	02	--	30	70	25	50	--	175	04	01
3	403143	Elective I	03	02	--	30	70	25	--	--	125	03	01
4	403144	Elective II	03	--	--	30	70	--	--	--	100	03	--
5	403145	Control System II	03	02	--	30	70	25	--	25	150	03	01
6	403146	Project I	--	--	02	--	--	--	--	50	50	02	--
	403152	Audit Course V											
		TOTAL	16	08	02	150	350	100	50	100	750	18	04

SEMESTER-II

Sr No	Subject Code	Subject Title	Teaching Scheme (Hrs/Week)			Examination Scheme (Marks)					Total Marks	Credit	
						PP							
			TH	PR	TU	In Sem	End Sem	TW	PR	OR		TH / TU	PR + OR
1	403147	Switchgear and Protection	03	02	--	30	70	50	--	25	175	03	01
2	403148	Power Electronic Controlled Drives	04	02	--	30	70	25	50	--	175	04	01
3	403149	Elective III	03	02	--	30	70	25	--	25	150	03	01
4	403150	Elective IV	03	--	--	30	70	--	--	--	100	03	--
5	403151	Project II	--	--	06	--	--	50	--	100	150	06	--
	403153	Audit Course VI											
TOTAL			13	06	06	120	280	150	50	150	750	19	03

TH	**Theory lectures hours/week**	**TW**	**Term work**
PR	**Practical hours/week**	**OR**	**Oral**
TU	**Tutorial hours/week**	**PP**	**Paper- In semester and End Semester**

Elective I (403143) **A) Fundamentals of Microcontroller MSP430 and its Applications [Open Elective]** **B) Power Quality** **C) Renewable Energy Systems** **D) Digital Signal Processing**	**Elective II (403144)** **A) Restructuring and Deregulation** **B) Electromagnetic Fields** **C) EHVAC Transmission** **D) Electric and Hybrid Vehicles** **E) Special Purpose Machines**
Elective III (403149) **A) High Voltage Engineering** **B) HVDC and FACTS** **C) Digital Control System** **D) Intelligent Systems and Applications in Electrical Engineering** **E) Analog Electronics and Sensing Technology [Open Elective]**	**Elective IV (403150)** **A) Smart Grid** **B) Robotics and Automation** **C) Illumination Engineering** **D) VLSI Design[Open Elective]**

Audit Course

- Audit Course: Optional for 1st and 2nd term of BE Electrical Engineering
- 'Audit Courses' means a Course in which the student shall be awarded Pass or Fail only. It is left to the discretion of the respective affiliated institute to offer such courses to the students. Evaluation of audit course will be done at institute level itself.
- Teaching-learning process for these subjects is decided by concern faculty/industry experts appointed by the affiliated Engineering College based on the syllabus and guidelines given.
- Marks obtained by student for audit course will not be taken into consideration of SGPA or CGPA.

Audit Course V **403152**	**(A) Hydro Energy Systems** **(B) Foreign Language – German**
Audit Course VI **403153**	**Energy Storage Systems**

403141: Power System Operation and Control

Teaching Scheme		Credits	Examination Scheme [150 Marks]	
Theory	: 03 Hr/Week	03	In Sem :	30 Marks
Practical	: 02 Hr/Week	01	End Sem :	70 Marks
			Oral :	25 Marks
			Term work :	25 Marks

Prerequisite:
Basics of Power System

Course Objective: The course aims:-

- To develop ability to analyze and use various methods to improve stability of power systems
- To understand the need for generation and control of reactive power
- To impart knowledge about various advanced controllers such as FACTs controllers with its evolution, principle of operation, circuit diagram and applications
- To illustrate the automatic frequency and voltage control strategies for single and two area case and analyze the effects, knowing the necessity of generation control.
- To understand formulation of unit commitment and economic load dispatch tasks and solve it using optimization techniques
- To illustrate various ways of interchange of power between interconnected utilities and discuss planning, reliability aspects at all stages of power system.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Identify and analyze the dynamics of power system and suggest means to improve stability of system.
2. Comprehend the effect of reactive power on Power system and suggest the suitable means of reactive power management.
3. Selection of appropriate FACTs devices
4. Analyze the generation-load balance in real time operation and its effect on frequency and develop automatic control strategies with mathematical relations.
5. Formulate objective functions for optimization tasks such as unit commitment and economic load dispatch and get solution using computational techniques.
6. Evaluate reliability indices of Power system

Unit 01 : Power System Stability (06 Hrs)

Introduction to stability, dynamics of synchronous machine, swing equation, power angle equation and curve, types of power system stability (concepts of steady state, transient, dynamic stability), equal area criterion, applications of equal area criterion (sudden change in mechanical input, effect of clearing time on stability, critical clearing angle, short circuit at one end of line, short circuit away from line ends and reclosure), solution of swing equation by point by point method, methods to improve steady state and transient stability, numerical based on equal area criteria.

Unit 02 : Reactive Power management (06 Hrs)

Necessity of reactive power control, reactive power generation by a synchronous machine, effect of excitation, loading capability curve of a generator, compensation in power system: series and shunt compensation using capacitors and reactors, Problems with Series Compensation, synchronous condenser.

Unit 03 : FACTs Technology (06 Hrs)

Problems of AC transmission system, evolution of FACTs technology, Working principle, circuit diagram, VI characteristics, applications, advantages and limitations of SVC, TCSC, STATCOM and UPFC.

Unit 04 : Automatic Generation and Control (AGC) (06 Hrs)

Concept of AGC, complete block diagram representation of load-frequency control of an isolated power system, steady state and dynamic response, control area concept, two area load frequency control. Schematic and block diagram of alternator voltage regulator scheme.

Unit 05 : Economic Load Dispatch and Unit Commitment (06 Hrs)

A. Economic load dispatch: Introduction, revision of cost curve of thermal and hydropower plant, plant scheduling method, equal incremental cost method, method of Lagrange multiplier (neglecting transmission losses), B_{mn} coefficient, economic scheduling of thermal plant considering effect of transmission losses, penalty factor, procedure of load dispatch at state level load dispatch center, Regional Load Dispatch Center, numerical on penalty factor, exact coordination equation.

B. Unit commitment: Concept of unit commitment, constraints on unit commitment – spinning reserve, thermal and hydro constraints, methods of unit commitment – priority list and dynamic programming, Numerical on priority list method.

Unit 06 : Energy Control and Planning and Reliability of Power Systems (06 Hrs)

A. **Energy Control:** Interchange of power between interconnected utilities, economy interchange evaluation, interchange evaluation with unit commitment, types of interchange, capacity and diversity interchange, energy banking, emergency power interchange, inadvertent power exchange, power pools.

B. **Planning and Reliability of Power Systems:** Need of short term planning and long term planning in generation, transmission, distribution expansion. Definition of reliability of power system, Hierarchical levels for reliability study, Reliability evaluation of generation system, loss of load probability (LOLP), loss of load expectation (LOLE), Expected Energy Not Supplied (EENS), generation model, load model, risk model, composite system reliability evaluation, Distribution system reliability evaluation for radial and parallel system, customer oriented and energy based reliability indices.

Guidelines for Instructor's Manual

Practical Sessions:-

Instructor's Manual should contain following things related to every experiment-

- Specify prerequisite and objective(s) of experiment.
- List out equipment required to perform the experiment with their ratings (for hardware experiments).
- Include circuit diagram with specifications (for hardware experiments).
- Related theory of the experiment must be included.
- The circuit diagram of the experiment should be drawn at the beginning.
- For simulation experiments using MATLAB, the Simulink diagram with proper details must be included in write up. For programming, take printout of program and result.
- Conclusion based on calculations, result and graph (if any) should be written. Provide space for same.

Guidelines for Student's Lab Journal

- Students should write the journal in own hand writing particularly results, diagram, conclusion, question answers etc.
- Circuit / Connection diagram or construction diagram must be drawn either manually using or using software on graph paper.
- Hand writing and figures must be neat and clean.

Guidelines for Laboratory / TW Assessment

- Continuous assessment is to be carried out. The experiment performed in a particular week must be checked in the next turn in next week.
- After assessment, teacher should put the remark by writing word "Complete" and not simply "C". Put the signature along with date at the end of experiment and in the index.

List of Experiments

[Perform experiment 1 or 2 and any seven from 3 to 11 using any simulation software]

1. To determine Steady state Stability of synchronous motor (performance).
2. To determine Steady state stability of medium transmission line (performance).
3. To plot swing curve by Point by Point method for transient stability analysis.
4. To apply equal area criteria for analysis stability under sudden rise in mechanical power input.
5. To apply equal area criteria for stability analysis under fault condition.
6. To study reactive power compensation using any device.
7. To study Lagrange multiplier technique for economic load dispatch.
8. To develop and execute dynamic programming method for unit commitment.
9. To study load frequency control using approximate and exact model.
10. To study load frequency control with integral control.
11. To study the two area load frequency control.

Industrial Visit:

Industrial visit is mandatory to Load Dispatch Center / Power Station Control Room.

Text Books:

[T1] I. J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4th Edition, Tata McGraw Hill Publishing Co. Ltd. (Edition 2)

[T2] Hadi Saadat, "Power System Analysis", Tata McGraw Hill

[T3] P. S. R. Murthy, "Power System Operation and Control", Tata McGraw Hill Publishing Co. Ltd.

[T4] P. S. R. Murthy, "Operation and Control in Power System", B. S. Publication.

[T5] R. Mohan Mathur, Rajiv K. Varma, "Thyristor based FACTs controller for Electrical transmission system", John Wiley and Sons Inc.

[T6] Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", Prentice Hall of India.

[T7] Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS", IEEE Press.

Reference Books:

[R1] Allen J. Wood, Bruce F. Wollenberg, "Power Generation, Operation, and Control", Wiley India Edition.

[R2] "Electrical Power System Handbook", IEEE Press.

[R3] Narain G. Hingorani, Laszlo Gyugyi, "Understanding FACTs Concepts and Technology of Flexible AC Transmission Systems," IEEE Press.

[R4] Olle I. Elgerd, "Electrical Energy System Theory", 2nd Edition, Tata McGraw Hill. Publishing Co. Ltd.

[R5] Prabha Kundur, "Power System Stability and Control", Tata McGraw Hill.

Websites:

1. http://www.mahasldc.in/
2. http://cercind.gov.in/
3. http://www.srldc.org/
4. https://nrldc.in/
5. http://www.mercindia.org.in/
6. http://www.erldc.org/
7. http://nptel.ac.in/courses/108101040/ (PSOC webcourse)
8. http://www.powergridindia.com/

Unit	Text Books	Reference Books
1	T1, T2, T6	R1, R2, R5
2	T3	R5
3	T5,T7	R3
4	T1	R1
5	T2,T4	R1, R4, websites
6	T1	R1

403142: PLC and SCADA Applications

Teaching Scheme	Credits	Examination Scheme [175 Marks]		
Theory : 04 Hr/Week	04	In Sem	:	30 Marks
Practical : 02 Hr/Week	01	End Sem	:	70 Marks
		PR	:	50 Marks
		Term work	:	25 Marks

Prerequisite:
Logic gates operations, Boolean algebra, Relay logic

Course Objective: The course aims:-

- To understand the generic architecture and constituent components of a Programmable Logic Controller.
- To develop architecture of SCADA explaining each unit in detail.
- To develop a software program using modern engineering tools and technique for PLC and SCADA.
- To apply knowledge gained about PLCs and SCADA systems to real-life industrial applications.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Develop block diagram of PLC and explain the working.
2. Classify input and output interfacing devices with PLC.
3. Develop architecture of SCADA and explain the importance of SCADA in critical infrastructure.
4. Execute, debug and test the programs developed for digital and analog operations.
5. Describe various SCADA protocols along with their architecture.
6. Observe development of various industrial applications using PLC and SCADA.

Unit 01 : Introduction to PLC (08 Hrs)

Role of automation in Industries, benefits of automation, Necessity of PLC, History and evolution of PLC, Definition as per NEEMA (National Electrical Engineering Manufacturers' Association), types – fixed/modular/dedicated, Overall PLC system, PLC Input and output modules (along with Interfaces), CPU, programmers and monitors, power supplies, selection criterion, advantages and disadvantages, specifications, comparison of various PLCs manufactured by Allen Bradley, Siemens, ABB, Mitsubishi, GE, Fanuc and Schneider.

Unit 02 : Interfacing of PLC with I/O devices (08 Hrs)

Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices Sensors-temperature, pressure, flow, level Actuators-Electrical, pneumatic, hydraulic Encoders-Incremental, Absolute Transducers, Limit switches, proximity sensors Control Elements- Mechanical, Electrical, Fluid valves

Unit 03 : Programming of PLC (09 Hrs)

Programming languages for PLC, Ladder diagram fundamentals, Rules for proper construction of ladder diagram Timer and counter- types along with timing diagrams, Reset instruction, latch instruction MCR (master control relay) and control zones Developing ladder logic for Sequencing of motors, ON OFF Tank level control, ON OFF temperature control, elevator, bottle filling plant, car parking, traffic light controller.

Unit 04 : Advance function and Applications of PLC (08 Hrs)

Analog PLC operation and PLC analog signal processing, PID principles, Typical continuous process control curves, simple closed loop systems, closed loop system using Proportional, Integral and Derivative (PID), PID modules, PID tuning, tuning methods including "Adjust and observe" method.

Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

PLC Applications in developing systems- Tank level controller using analog signals, temperature controller using RTD, speed control of electric motor.

Unit 05 : SCADA Systems (08 Hrs)

Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, important definitions HMI, MTU, RTU, communication means, Desirable Properties of SCADA system, advantages, disadvantages and applications of SCADA.

SCADA generations (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), SCADA systems in operation and control of interconnected power system, Functions and features of SCADA systems, Automatic substation control, Energy management systems (EMS), System operating states, SCADA system in critical infrastructure: Petroleum Refining Process, Conventional electric power generation, Water Purification System, Chemical Plant.

Unit 06 : SCADA Protocols (07 Hrs)

Open systems interconnection (OSI) Model, TCP/IP protocol, Modbus model, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), Device Net, Control Net, Ether Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus).

Guidelines for Instructor's Manual

- Specify objective(s) of the experiment.
- Include ladder diagram.
- Related theory of the experiment must be included.
- Include step by step procedure to perform the experiment.
- Tabular representation of results taken from the experiment/observation table must be included wherever applicable.
- Provide space to write conclusion.

Guidelines for Student's Lab Journal

➢ Students are expected to write the journal in the following sequence:
- Aim –
- Ladder diagram –
- Theory –
- Conclusion.

➢ Students are expected to draw the ladder diagrams on 1mm graph paper.
➢ They should attach print out or draw SCADA HMI.
➢ Students should write conclusion.
➢ Students should get the assignment and lab write up checked within 1 week after performing the experiment.

Guidelines for Laboratory conduction

- Give the safety instructions to students.
- Allow 4-5 students per group for performing the experiment.
- Explain theory related to the experiment to be conducted.
- Introduce PLC and SCADA in detail with specifications to students.
- Explain the ladder diagram of the experiment.
- Ladder diagram should be completed by the students.
- Perform the experiment in the presence of instructor.
- Verify the results obtained.

List of Experiments:

Minimum 11 experiments should be conducted. 6 experiments should be on PLC and 5 experiments should be on SCADA.

a) Experiments No. 1 to 5 are compulsory.
b) Any 1 experiment should be conducted from experiment number 6 to 9.
c) Experiments No. 10 to 13 are compulsory.
d) Any 1 experiment should be conducted from experiment number 14 to 17.

1. Interfacing of lamp and button with PLC for ON and OFF operation. Verify all logic gates.
2. Set / Reset operation: one push button for ON and other push button for OFF operation.
3. Delayed operation of lamp by using push button.
4. UP/DOWN counter with RESET instruction.
5. Combination of counter and timer for lamp ON/OFF operation.
6. DOL starter and star delta starter operation by using PLC.
7. PLC based thermal ON/OFF control.
8. Interfacing of Encoder with PLC
9. PLC based speed, position, flow, level, pressure measurement system.
10. PLC interfaced with SCADA and status read/command transfer operation.
11. Parameter reading of PLC in SCADA.
12. Alarm annunciation using SCADA.
13. Reporting and trending in SCADA system.
14. Tank level control by using SCADA.
15. Temperature monitoring by using SCADA.
16. Speed control of Machine by using SCADA.
17. Pressure control by using SCADA.

Industrial Visit: Compulsory visit to SCADA and PLC based automation industry.

Text Books:

[T1] John W. Webb, Ronald A. Reis, "Programmable Logic Controllers: Principles and Application", PHI Learning, New Delhi, 5th Edition

[T2] John R. Hackworth, Frederick D., Hackworth Jr., "Programmable Logic Controllers Programming Methods and Applications", PHI Publishers

[T3] Ronald L. Kurtz, "Securing SCADA System", Wiley Publishing

[T4] Stuart A Boyer, "SCADA supervisory control and data acquisition", ISA, 4th Revised edition

[T5] Sunil S. Rao, "Switchgear and Protection", Khanna Publication

[T6] Curtis Johnson, "Process Control Instrumentation Technology", Prentice Hall of India

[T7] Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2nd Edition

Reference Books:

[R1] Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols”, ELSEVIER

[R2] Batten G. L., “Programmable Controllers”, McGraw Hill Inc., Second Edition

[R3] Bennett Stuart, “Real Time Computer Control”, Prentice Hall, 1988

[R4] Krishna Kant, “Computer Based Industrial Control”, PHI

[R5] P. K. Srivstava, “Programmable Logic Controllers with Applications”, BPB Publications

Unit	Text Books	Reference Books
1	T1	R2
2	T1, T2, T6	R3, R4
3	T1, T7	R5
4	T1, T2, T6	R2, R5
5	T3, T4, T5	R1
6	T3	R1

Elective I : 403143 (A) : Fundamentals of Microcontroller MSP430 and its Applications [Open Elective]

Teaching Scheme		Credits	Examination Scheme [125 Marks]		
Theory	:03 Hr/Week	03	In Sem	:	30 Marks
Practical	:02 Hr/Week	01	End Sem	:	70 Marks
			Term work	:	25 Marks

Prerequisite:

Basic knowledge of Number system.
Knowledge of basic logic components.
Programming skills in C Language.

Course Objective: The course aims to:-

- Provide understanding of architecture of MSP430 microcontroller
- Develop ability to write and interpret C language programs for MSP430
- Use advance features in PWM for MSP430
- Interface various devices with MSP430
- Understand use of MSP 430 for IoT applications

Course Outcome: Upon successful completion of this course, the students will be able to:-

1. Explain architecture of MSP430 microcontroller, its instructions and the addressing modes.
2. Develop and debug program in C language for specific applications.
3. Use of Code Composer Studio IDE for simulating the functionalities of MSP430 microcontroller
4. Interface microcontroller MSP430 to various sensing devices.
5. Develop IoT based application using MSP430.

Unit 01 : Overview of MSP430 (06 Hrs)

Basics of Embedded Systems, Introduction to MSP430, RISC Architecture / Functional Block Diagram of MSP430G2553, Pin Diagram, Memory Organization, CPU, On-Chip-Peripherals. Overview of MSP430G2 Launchpad and its Features.

Unit 02 : Digital I/O, Interrupts and basic of programming (06 Hrs)

GPIO programming and I/O multiplexing; Interrupts and interrupt programming, Issues associated with interrupts, Capacitive touch I/O pin interface.

Software and hardware tools for development of MSP430 based system such as assembler, compiler, IDE, Emulators, debugger, programmer.

Unit 03 : Timers, PWM Control and RTC (06 Hrs)

Watchdog timer, Timers, Measurement in Capture Mode, PWM control – Edge-Aligned PWM, Centred PWM and Sine-PWM, Real Time Clock (RTC).

Unit 04 : ADC and Operating Modes (06 Hrs)

Analog-to-Digital Conversion: General Issues, Successive Approximation. Basic Operation of ADC10, Advanced Operation of ADC10, ADC10 Successive Approximation, Digital to Analog Conversion.

Low Power aspects of MSP430: Operating Modes, low power modes, Active vs Standby current consumption, FRAM vs Flash for low power; reliability.

Unit 05 : Communication (06 Hrs)

Serial communication basics, USCI, Synchronous/Asynchronous interfaces (like UART, USB, SPI, and I2C), UART protocol, I2C protocol, SPI protocol, Implementing and programming UART, I2C, SPI interface using MSP430, Interfacing external devices.

Unit 06 : IoT Basics and Applications of MSP430 (06 Hrs)

IoT overview and architecture, Overview of wireless sensor networks and design examples. Various wireless connectivity: NFC, ZigBee and Bluetooth.

Real world application: MSP430 based Embedded Networking Application: "Implementing Wi-Fi or Bluetooth Connectivity in a Smart Electric Meter".

Guidelines for Instructor's Manual

Instructor's Manual shall have

- Brief relevant theory.
- Equipment with specifications.
- Connection diagram/ methodology.
- Format of observation table and sample results.

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two reading.
6. Result table.
7. Graph and Conclusions.
8. Few short questions related to the experiment.

Guidelines for Laboratory conduction

Lab Requirement:MSP430F2553 Launch Pad, Desktop/ Laptop with Windows7/8 operating system, System with installed circuit CCS software, Breadboard, Single strand and jumper wires, MSP430 Capacitive Touch Booster-Pack, CC3100 Wi -Fi Booster Pack.

List of Experiments

Minimum 8 experiments are to be performed from the following list:

1) Digital I/O: Learn and understand how to configureMSP-EXP430G2553 / MSP-EXP430F5529 digital I/O pins. Write a C program for configuration of GPIO ports for MSP430 (blinking LEDs, push buttons interface).

   Exercises: a) modify the code to make the green and red LEDs blink: Together and alternatively

   b) Modify the delay with which the LED blinks: Together and alternatively

   c) Modify the code to make the green LED blink: Together and alternatively

2) Timer/Interrupt: Learn and understand GPIO based Interrupt programming in MSP-EXP430G2553 / MSP-EXP430F5529. Write a C program and associated GPIO ISR using interrupt programming technique.

   Exercises:

   a) Write the code to enable a timer interrupt for the pin.
   b) Write the code to turn on interrupts globally.
   c) LED Blink using timer instead of software delay.

3) PWM: Implement Pulse Width Modulation to control the brightness of the on-board, green LED. Exercises:

   a) Observe the PWM waveform using CRO / DSO.
   b) What is the maximum resolution of PWM circuitry in MSP-EXP430G2553 / MSP-EXP430F5529?
   c) Change the above code to create a PWM signal of 75% duty cycle on PWM pin.

4) PWM (Continued): Implement Advanced Pulse Width Modulation techniques

   Exercises:

   a) Edge-Aligned and Center Aligned PWM.
   b) Sine-PWM generation.

5) ADC: Learn and understand how to configure the ADC module to control the brightness of LED.

   Exercises:

   a) Read ADC value and observe in Watch window
   b) Change PWM duty cycle based on ADC value and control brightness of LED using a pot connected to ADC pin.

6) Configure of Universal Serial Communication Interface (USCI) module ofMSP-EXP430G2553 / MSP430F5529 for UART based serial communication. The main objective of this experiment is to use UART of the MSP-EXP430G2553 / MSP430F5529 to communicate with the computer.

   Exercise:

   a) Modify the above code to transmit the set of strings to the serial terminal via UART as shown below:

      char str1[]="MSP-EXP430G2553 / MSP430F5529 MCU"
      char str2[]= "Ultra low power mixed signal processing applications"

7) Capacitive I/O interface: Understand and interface a Capacitive Booster pack with MSP430.
Exercise:
   a) Implementing Capacitive Booster Pack Demo

8) On chip temperature Sensor and ADC interface demo: To implement the on-chip temperature sensor demo.
Exercise:
   a) Implementing Temperature Sensor and ADC interface Demo

9) Bluetooth Interface: Transmit Data wirelessly over Bluetooth for any chosen IoT application
Examples:
   a) Temperature Sensor
   b) Humidity Sensor
   c) Position Sensor
   d) Proximity Sensor
   e) Current Sensor
   f) Voltage Sensor
   g) Pressure Sensor
   h) Or any other sensor interfaced with MSP430.

10) Closed loop temperature/speed control system using MSP430.

Lab Manual:

1) www.ti.com/lab-maunals

Embedded System Design using MSP430 Launchpad Development Kit – Lab Manual

Text Books:

[T1] Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880

[T2] MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN- 13: 978-0750682763

Other References:

[R1] http://www.ti.com/lit/ds/symlink/msp430g2553.pdf

[R2] http://www.ti.com/lit/ug/tidu520/tidu520.pdf

[R3] http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_Low_Power_Mode

Unit	Text Books	Reference Books
1	T1	R1
2	T2	R1, R3
3	T2	R1
4	T2	R1
5	T2	R1
6	-	R2

Elective I: 403143 (B) : Power Quality

Teaching Scheme	**Credits**	**Examination Scheme [125 Marks]**		
Theory : 03 Hr/Week	03	In Sem	:	30 Marks
Practical : 02 Hr/Week	01	End Sem	:	70 Marks
		Term work	:	25 Marks

Prerequisite:
Fundamentals of Power system and Power electronics.

Course Objective: The course aims to:-

- Develop ability to identify various power quality issues, its sources and effects on various equipments.
- Monitor and analyze various power quality problems
- Describe and selection of cost effective power quality mitigation solutions.
- Explain use of power quality standards

Course Outcome: Upon successful completion of this course, the students will be able to:-

1. Identify importance of various power quality issues.
2. Carry out power quality monitoring
3. List and explain various causes and effects of power quality problems
4. Analyze power quality parameters and carry out power quality analysis
5. Select cost effective mitigation technique for various power quality problems
6. Use IEEE 519-2014 power quality standard for harmonic compliance

Unit 01 : Basics of power quality (06 Hrs)
Introduction and importance of power quality, symptoms of poor power quality. Classification of power quality events, power quality definition as per IEEE 1159.Grounding of sensitive electronic equipments and guidelines of IEEE std 1100.Long duration RMS voltage variations, its sources, effects and solutions.

Unit 02 : Voltage Sag (06 Hrs)
Sources of voltage sags, classification of voltage sags, factors governing severity of voltage sag. Area of vulnerability, critical distance. Voltage sag characteristics. Classification of equipments based on its sensitivity to various characteristics of voltage sag. Effect of voltage sag on various equipments. Voltage tolerance curve, ITIC and SEMI F47 curve, investigation of sensitivity of equipments to voltage sags. Voltage sag mitigation techniques at equipment level, LT power entrance and medium voltage. Voltage sag indices. Study of important provisions in IEEE Std 1346.

Unit 03 : Transient Overvoltage and Flicker (06 Hrs)
Sources of transient over voltages, Impulsive and oscillatory transients. Magnification of capacitor switching transients, pre insertion reactors to control capacitor switching transients, ferroresonance, principle of over voltage protection. Devices for over voltage protection. Voltage flicker, its sources. Factors governing severity of flicker. Flicker measurement, Pst and Plt. Flicker mitigation solutions.

Unit 04 : Fundamentals of Harmonics (06 Hrs)
Waveform Distortion, Harmonics, Harmonic phase sequences. Classification of harmonics harmonic, Voltage Verses Current distortion, AC quantities under non-sinusoidal conditions, Voltage and current harmonic indices, Sources of harmonics, General and special Effects of Harmonics on Electrical Equipments, cables, switchgears, Meters and Communications.

Unit 05 : Harmonic Mitigation Techniques (06 Hrs)

System behaviour to harmonics, location of harmonic sources, Series and parallel resonance, Harmonic mitigation, passive tuned and detuned filters, design of tuned filters, Active Filter, Sizing and location of active filters, Advantages of active filters over passive filters, Hybrid filters. IEEE 519-2014 standard.

Unit 06 : Power Quality Monitoring (06 Hrs)

Objectives of Power quality monitoring. Types of power quality monitoring, Power quality monitoring equipments, Power quality analyser specification requirement as per EN50160 Standard. Selection of power quality equipments for cost effective power quality monitoring, selection of voltage and current transducers. Power quality indices. IEEE 1159 standard and important provision related with power quality monitoring. Computer Tools for analysis of power quality.

Guidelines for Instructor's Manual

Instructor's Manual shall have

- Brief relevant theory.
- Equipment with specifications.
- Connection diagram/ methodology.
- Format of observation table and sample results.

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

9. Theory related to the experiment.
10. Apparatus with their detailed specifications.
11. Connection diagram /circuit diagram.
12. Observation table/ simulation waveforms.
13. Sample calculations for one/two reading.
14. Result table.
15. Graph and Conclusions.
16. Few short questions related to the experiment.

Guidelines for Laboratory conduction

- Read and understand power quality analyzer manual completely.
- Make sure that connections of power analyzer are done as per manual.
- Follow safety protocols while doing power quality audit.

List of Experiments

Minimum 8 experiments are to be performed from the following list:

Compulsory experiments:

1. Study of power quality analyzer and measurement of voltage, current, power and power factor using it.
2. Measurement of harmonic distortion of various Equipments such as UPS /AC/DC drive
3. Harmonic compliance of institute as per IEEE 519-2014 standard and sizing of active filter.
4. Power quality audit of institute or department.

Any 4 experiments from following list:

1. Harmonic analysis of transformer for various conditions (no load, inrush, full load etc.)
2. Analysis of performance of induction motor/transformer operated with sinusoidal supply and under distorted supply conditions supplied by 3 phase inverter.
3. Measurement of voltage sag magnitude and duration by using digital storage oscilloscope/ power quality analyzer.
4. Design of 7% detuned Passive Filter
5. Simulation study of transient and/or flicker measurement.
6. Simulation studies of harmonic generation sources such as VFD, SVC, STATCOM and FACTS devices and harmonic measurement (THD) by using professional software like MATLAB.
7. Harmonic load flow analysis by using professional software such as ETAP, PSCAD, ATP etc.

Text Books:

[T1] R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, “Electrical Power System Quality”, 2nd Edition, McGraw Hill Publication.

[T2] M. H. J. Bollen, “Understanding Power Quality Problems, Voltage Sag and Interruptions”, New York: IEEE Press, 2000, Series on Power Engineering.

[T3] C.Sankaran “Power quality”, CRC Press

[T4] Arrillaga, M. R. Watson, S. Chan, “Power System Quality Assessment”, John Wiley and Sons.

Reference Books:

[R1] Enriques Acha, Manuel Madrigal, “Power System Harmonics: Computer Modeling and Analysis”, John Wiley and Sons Ltd.

[R2] Ewald F. Fuchs, Mohammad A. S. Masoum, “Power Quality in Power Systems and Electrical Machines” Elsevier Publication.

[R3] G. J. Heydt, “Electric Power Quality”, Stars in Circle Publications

[R4] EN50160and IEEE 1100, 1346,519 and 1159 standards

[R5] Arrillaga, M. R. Watson, “Power System Harmonics”, John Wiley and Sons

Unit	Text Books	Reference Books
1	T1,T2, T3	R3, R4
2	T1,T2,T3	R2, R3, R4
3	T1,T2,T3	R2, R3
4	T1,T3,T4	R1, R4, R5
5	T1,T3,T4	R1, R4, R5
6	T1,T3	R1, R4

403143 (C) : Renewable Energy Systems

Teaching Scheme		Credits	Examination Scheme [125 Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			Term work	:	25 Marks

Prerequisite: Knowledge of basic renewable technologies like solar, wind, biogas, fuel cell, Knowledge of conventional grid

Course Objective: The course aims:-
- To develop fundamental understanding about Solar Thermal and Solar Photovoltaic systems.
- To provide knowledge about development of Wind Power plant and various operational as well as performance parameter/characteristics.
- To explain the contribution of Biomass Energy System in power generation.
- To describe different Storage systems, Integration and Economics of Renewable Energy System.

Course Outcome: Upon successful completion of this course, the students will be able to :-
1. Describe various renewable energy sources such as Solar Photovoltaic, Biomass, Wind, Fuel cell and Solar thermal.
2. Explain different renewable energy sources as an alternate for conventional power sources in any application of energy.
3. Identify and locate the use of renewable energy sources as per the requirement of the location.
4. Analyze, assess and design renewable energy systems such as solar and wind sources.
5. Compare the various storage sources for electrical energy.
6. Describe the standards for renewable energy source integration and evaluate economics related to these sources.

Unit 01 : Solar Thermal (06 Hrs)

Solar radiation at the Earth's surface, solar constant, spectral distribution, Extra-terrestrial radiation, solar terrestrial radiation, solar radiation geometry, Introduction to the concept of monthly average daily and hourly global and diffuse radiation, beam and diffuse radiation under cloudless skies, solar radiation on tilted surfaces: a) beam radiation, b) diffuse radiation, c) reflected radiation, d) flux on tilted surface.

Instruments for measuring solar radiation, Basics of flat plate collector, concepts of solar water heating system and space heating system, solar dryer, introduction to Concentrating Solar Power (CSP) plants using technologies like a) parabolic troughs b) linear Fresnel reflector c) paraboloid dish

Unit 02 : Solar PV (06 Hrs)

Introduction to various solar PV technologies, Single c-Si, Poly c-Si, thin film PV Cell, Module and Array, factors influencing the electrical design of the solar system: a) Sun Intensity b) Sun Angle c) Shadow Effect d) Temperature Effect e) Effect of Climate f) Electrical Load Matching g) Sun Tracking; Peak Power Point Operation, Electrical characteristics of Silicon PV Cells and Modules, PV System Components, Efficiency of PV system.

Design of typical solar PV system with and without battery backup for applications such as homes, commercial complex, agriculture etc.

Unit 03 : Wind Energy System (06 Hrs)

Types of wind turbine, Site selection, Power Contained in Wind, Aerodynamics of Wind Energy, Efficiency Limit for Wind Energy Conversion, Maximum Energy obtained for a Thrust-operated converter (Efficiency limit), Introduction to the Design of Wind Turbine Rotor, Power-Speed Characteristics, Wind Turbine Control Systems: a) Pitch Angle Control b) Stall Control c) Power Electronics Control d) Yaw Control; Control Strategy, Introduction to Offshore Wind Energy System and its comparison with on grid Wind Energy System

Unit 04 : Biomass Energy System (06 Hrs)

Biomass Classification, Biomass Resources and their Energy Potential, Biomass Conversion Technologies: Anaerobic Digestion, Ethanol Fermentation, Biomass Gasification: Gasifiers, Fluidized Bed Gasifier, Biogas Technologies and their factor affecting Biogas Production, Biogas Plants: Floating and Fixed Dome type, Introduction to other bio-reactors such as CSTR and UASB, designing of biogas plant. Power Generation from Municipal Solid Waste (MSW), Land Fill Gas, Liquid Waste. Introduction to organic fertilizers from digest state.

Unit 05 : Fuel cell and Storage Systems (06 Hrs)

a) Fuel Cells: Introduction to Fuel Cell Technology; type of fuel cells, Operating principles of Fuel Cell, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, application and limits.

b) Energy Storage systems: Hydrogen storage: Hydrogen production, relevant properties, Hydrogen as an Engine Fuel, methods of Hydrogen storage.

Batteries: Introduction to Batteries, Elements of Electro Chemical Cell, Battery classification, Battery Parameters, Factors affecting battery performance.

Grid scale storage, various options available (pumped storage, SMES, compressed air storage, fly wheels, etc.), requirements, future trends, Introduction to the concepts of round trip efficiency and cost of storage.

Unit 06 : Integration and Economics of Renewable Energy Systems (06 Hrs)

a) Integration of RES with grid, standards., Introduction to hybrid systems

b) Economics of RES: Simple payback, Internal Rate of Return (IRR), time value, Net present value (NPV), Life cycle costing, Effect of fuel cost Escalation, Annualized and levelized cost of energy

Guidelines for Instructor's Manual

Manual must have assignment related to theory of each experiment.

Guidelines for Student's Lab Journal

A separate notebook/file is required for experiments. Top of the page must have experiment number, title of experiment, date of experiment. It is to be followed by observations, calculations and results. The laboratory notebook must be checked by the staff in-charge of the experiment. Journal must have observations and conclusions written neatly. The experiments must be assessed by the proper authority before submission.

Guidelines for Laboratory conduction

Minimum 08 experiments should be conducted from the list given below:

List of Experiments

1. To identify and measure the parameters of a Solar PV Module with Series and/or Parallel combination.
2. To plot I-V and P-V characteristics with series and parallel combination of Solar PV Modules for different Insolation and temperature effects.
3. To evaluate effect of Shading and Tilt Angle on I-V and PV characteristics of Solar Module.
4. To estimate effect of sun tracking on energy generation by Solar PV Module.
5. To estimate efficiency of standalone Solar PV Module.
6. To evaluate performance of Solar flat plate collector.
7. To plot characteristics of lead-acid battery for various source and load condition.
8. To analyze effect of blade angles on performance of wind turbine.
9. To evaluate performance of horizontal axis wind turbine.
10. To evaluate performance evolution of vertical axis wind turbine.
11. To study synchronization of wind electric generator.
12. Wind generation analysis using Matlab for variable wind speeds.
13. To evaluate efficiency of DFIG System (Hardware setup only).

Industrial Visit: Field visit to Renewable Energy Sources locations or Manufacturing Industry

Text Books:

[T1] S.P. Sukhatme, "Solar Energy," Tata McGraw Hill

[T2] Mukund R. Patel, "Wind and Power Solar System", CRC Press

[T3] Chetan Singh Solanki, "Solar Photovoltaics-Fundamentals, Technologies and Applications", PHI Second Edition

[T4] H. P. Garg, J. Prakash, "Solar Energy-Fundamentals and Applications", Tata McGraw hill Publishing Co.ltd., First Revised Edition

[T5] Tony Burton, Nick Jenkins, David Sharpe, "Wind Energy Hand Book-Second Edition", John Wiley & Sons, Ltd., Publication

[T6] Godfrey Boyle, "Renewable Energy", Third edition, Oxford University Press

[T7] S. Rao, Dr. B. B. Parulekar, "Energy Technology – Non Conventional, Renewable and Conventional", Khanna Publication

Reference Books:

[R1] D. P. Kothari, K. C. Singal, Rakesh Rajan, "Renewable Energy Sources and Emerging Technologies", PHI Second Edition

[R2] Donald L.Klass, "Biomass for Renewable Energy, Fuels, and Chemicals, Elsevier, Academic Press

[R3] B T.Nijaguna, "Biogas Technology", New Age International Publishers

[R4] Tapan Bhattacharya, "Terrestrial Solar Photovoltaics", Narosa Publishing House

[R5] Thomas Ackermann, "Wind Power in Power Systems", Wiley Publications

Unit	Text Books	Reference Books
1	T1, T4	R4
2	T2, T3	R1
3	T5	R5
4	T7	R2,R3
5	T3,T6	R1
6	T6, T7	R1

Elective I: 403143 (D): Digital Signal Processing

Teaching Scheme		Credits	Examination Scheme [125 Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			Term work	:	25 Marks

Prerequisite:
Knowledge of basic signals and systems

Course Objective: The course aims:-

- To elaborate Sampling theorem
- To classify discrete signals and systems
- To analyze DT signals with Z transform, inverse Z transform and DTFT
- To describe Frequency response of LTI system
- To introduce Digital filters and analyze the response
- To demonstrate DSP Applications in electrical engineering

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Sample and reconstruct any analog signal
2. Construct frequency response of LTI system
3. Evaluate Fourier Transform of discrete signals
4. Design IIR filter and its implementation
5. Design FIR filter and implementation
6. Develop block diagram for DSP applications to electrical engineering

Unit 01 : Classification of Signals: (06 Hrs)
Analog, Discrete-time and Digital signals, Basic sequences and sequence operations, Discrete-time systems, Properties of D. T. Systems and Classification, Linear Time Invariant Systems, impulse response, linear convolution and its properties, properties of LTI systems: stability, causality, parallel and cascade connection, Linear constant coefficient difference equations, Periodic Sampling, Sampling Theorem, Frequency Domain representation of sampling, reconstruction of a band limited Signal, A to D conversion Process: Sampling, quantization and encoding.

Unit 02 : Z-transform, Inverse Z-transform and its properties: (06 Hrs)
Unilateral Z-transform, Z transform properties: Linearity, time shifting, multiplication by exponential sequence, differentiation, conjugation, time reversal, convolution, initial value theorem, Inverse z transform by inspection, partial fraction, power series expansion and complex inversion, solution of difference equation

Unit 03 : Discrete Time Fourier Transform (06 Hrs)
Representation of Sequences by Fourier Transform, Symmetry properties of D. T., F. T. theorems: Linearity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, Frequency response analysis of first and second order system, steady state and transient response

Unit 04 : Discrete Fourier Transform (06 Hrs)
Sampling theorem in frequency domain. The Discrete Fourier Transform, Relation with z transform Properties of DFT: Linearity, circular shift, duality, symmetry, Circular Convolution, Linear Convolution using DFT, Effective computation of DFT and FFT, DIT FFT, DIF FFT, Inverse DFT using FFT

Unit 05 : Frequency Response of LTI Systems: (06 Hrs)
Ideal frequency selective filters, Concept of filtering, specifications of filter, IIR filter design from continuous time filters: Characteristics of Butterworth, and Cheybyshev low pass filter, impulse invariant and bilinear transformation techniques, Design examples, Basic structures for IIR Systems: direct form, cascade form

Unit 06 : FIR filter design using windows: (06 Hrs)
specifications of properties of commonly used windows, Design Examples using rectangular, and hanning windows. Basic Structures for FIR Systems: direct form. Comparison of IIR and FIR Filters Applications: Measurement of magnitude and phase of voltage, current, power, frequency and power factor correction, harmonic Analysis and measurement, applications to machine control, DSP based protective relaying.

Guidelines for Instructor's Manual

Instructor's Manual should contain following related to every experiment –

- Theory related to the experiment.
- Basic MATLAB instructions for DSP/ Simulink basics.
- Observation table/ Expected simulation results.
- Sample calculations for one/two reading.
- Result table

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

- Theory related to the experiment
- Circuit diagram/Simulink diagram/MATLAB program
- Simulation results
- Sample calculations for one/two reading
- Result table, Conclusion
- Few short questions related to the experiment

Guidelines for Laboratory conduction

- Assessment must be based on understanding of theory, attentiveness during practical session.
- Assessment should be done how efficiently student is able to perform experiment/simulation and get the results.
- Understanding fundamentals and objective of experiment, timely submission of journal.

List of Experiments: :
[Minimum eight experiments are to be performed]
Note: Perform the practical using C language or any other professional software for group A and B

GROUP-A (Any Three)
1. Plotting of discrete time waveforms (a) Sin, (b) Unit Step, (c) Exponential.
2. Find Linear convolution
3. Plot frequency response of given system function (Magnitude and Phase)
4. Verification of Z-transform properties (any two)

GROUP-B (Any Four)
1. Find DFT and IDFT of sequence
2. Find Circular convolution Using DFT IDFT method and linear convolution using Circular convolution.
3 DIT- FFT or DIF-FFT algorithm
4. Design of IIR filter (Butterworth method).
5. Design of FIR filter (window (any one) method).

Group-C (Any one)
1. Study of DSP starter kit and generation of Sine wave.
2. Discrete implementation of FIR Filter using PIC18F/DSP kit.
3. Discrete implementation of IIR Filter using PIC18F/DSP kit.
4. Harmonic analysis of any non-sinusoidal signal using DSP.

Text Books:

[T1] Proakis J., Manolakis D., “Digital signal processing”, 3rd Edition, Prentice Hall, ISBN 81- 203-0720-8
[T2] P. Ramesh Babu, “Digital Signal Processing”, 4th Edition Scitech Publication
[T3] Dr.S. D. Apte,”Digital Signal Processing”,2nd Edition Wiley India Pvt. Ltd ISBN: 978-81-265-2142-5
[T4] W.Rebizant, J.Szafran, A.Wiszniewski, “Digital Signal Processing in Power system Protection and Control”, Springer 2011 ISBN 978-0-85729-801-0

Reference Books:

[R1] Mitra S., “Digital Signal Processing: A Computer Based Approach”, Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
[R2] A.V. Oppenheim, R. W. Schafer, J. R. Buck, ”Discrete Time Signal Processing”, 2nd Edition Prentice Hall, ISBN 978-81-317-0492-9
[R3] Steven W. Smith, “Digital Signal Processing: A Practical Guide for Engineers and Scientists”,1st Edition Elsevier, **ISBN:** 9780750674447

Unit	Text Books	Reference Books
1	T1,T2	R1,R2,R3
2	T1,T2	R2,R3
3	T1,T2	R2,R3
4	T1,T2	R2,R3
5	T1,T2,T3	R1,R2,R3
6	T4	R3

Elective II : 403144 (A) : Restructuring and Deregulation

Teaching Scheme		Credits	Examination Scheme [100Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
			End Sem	:	70 Marks

Prerequisites: Knowledge in power system analysis and power system generation, transmission and distribution.

Course Objective: The course aims:-

- To educate students about the process and operation of restructuring of power system.
- To familiarize students about the various power system restructuring models.
- To elaborate students pricing of electricity.
- To explain fundamental concept of congestion, its management and transmission pricing.

Course Outcome: Upon successful completion of this course, the students will be able to: -

1. Enlist the functions of various key entities in India and explain the implications of various policies and acts on restructuring and deregulation.
2. Describe the regulatory process in India along with various methods of regulations.
3. List the components involved in tariff determination.
4. Explain different power sector restructuring models
5. Explain different types of electricity markets.
6. State different transmission pricing methods and discuss congestion management

Unit 01 : Power Sector Reforms in India (06 Hrs)

Need of Regulation. Institutional structure before reforms and after reforms. Roles of various key entities like Ministry of Power, CEA, Planning Commission, CERC and SERC in India. Electricity Act 2003 and 2010 and its implications for Restructuring and Deregulation. National Energy policy. Critical issues and challenges before the Indian power sector.

Unit 02 : Power Sector Regulation (06 Hrs)

Regulatory process in India, Principles of Tariff setting, Phases of Tariff determination, types and methods of Regulation, cost plus, performance-based regulation, price cap, revenue cap, rate of return regulation, benchmarking or yardstick regulation. Considerations of socio economic aspects in regulation.

Unit 03 : Power Sector Economics (06 Hrs)

Introduction to various concepts such as capital cost, debt and equity, depreciation, fixed and variable costs, working capital. Typical cost components of utilities such as return in equity, depreciation, interest and finance charges, O and M expenses etc. Key Indices for assessment of utility performances (Generation, transmission and distribution). Financial tools to compare investment options.

Unit 04 : Power Sector Restructuring Models and Introduction to energy Markets (06 Hrs)

Introduction, models based on energy trading or structural models – monopoly, single buyer, wholesale competition, retail competition. Models based on contractual arrangements – pool model, bilateral dispatch, pool and bilateral trades, multilateral trades. ISO models. Introduction to Energy Exchange, Day ahead market (DAM) and Term ahead market (TAM) procedure adopted in Energy exchanges and trading of Renewable Energy Credits and Carbon Credits.

Unit 05 : Electricity Markets (06 Hrs)

Rules that govern electricity markets, peculiarity of electricity as a commodity. Various electricity markets such as spot markets, forward contracts and forward markets, future contracts and future markets, day ahead market, reserve market, ancillary services market, market for differences, Options contracts. Market operation- settlement process, Market Clearing Price (MCP), Market efficiency, Market power.

Unit 06 : Transmission Pricing and Transmission Congestion issues (06 Hrs)

Cost components of transmission system, Cost allocation of Transmission system, Transmission pricing methods, physical transmission rights, Open Access, Role of Load Dispatch centers (SLDC, RLDC and NLDC). Congestion in power network, reasons for congestion, congestion management.

Text Books:

[T1] Know Your Power: A citizen Primer on the electricity Sector, Prayas Energy Group, Pune

[T2] Daniel S. Kirschen, Goran Strbac, "Power System Economics" John Wiely and Sons Publication Ltd. August 2006.

[T3] Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured Electrical Power Systems: Operation Trading and Volatility" CRC Press, 06-Jun-2001

Reference Books:

[R1] Steven Stoft, "Power System Economics: Designing Markets for Electricity", John Wiley and Sons, 2002

[R2] Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc

[R3] Geoffrey Rothwell, Tomas Gomez, "Electricity Economics Regulation and Deregulation" A John Wiley and Sons Publication 2003

[R4] Mohammad Shahidehpour, Hatim Yamin, Zuyi Li, "Market operations in Electric Power System" A John Wiley and Sons Publication.

[R5] Deregulation in Power Industry – A course under continuing Education Program, Department of Electrical Engineering , IIT , Bombay

Websites:

1 http://www.cercind.gov.in/Function.html
2 www.cercind.gov.in/serc.html
3 http://www.power.gov.ng/index.php/about-us/our-functions
4 http://www.cea.nic.in/functions.html
5 http://planningcommission.nic.in/reports/genrep/arep9920/ar9920role.htm

Unit	Text Books	Reference Books
1	T1	Websites 1-5
2	T1	R3
3	T1	R1
4	T2	R5
5	T2	R5, R2, R4
6	T3	R1

Elective II : 403144 (B) : Electromagnetic Fields

Teaching Scheme	Credits	Examination Scheme [100 Marks]
Theory : 03 Hr/Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisite: Coordinate system, Vector algebra, Electric field intensity, Magnetic field intensity, Fundamental relations for electrostatic and magnetostatic fields

Course Objective: The course aims:-

- To impart knowledge on the basics of electric and magnetic fields and their applications for utilization in the development of the theory for power transmission lines and electrical machines.
- To describe how materials affect electric and magnetic fields
- To discuss the boundary conditions
- To analyze the relation between the fields under time varying situations
- To give insight to Maxwell's equations in different form and media

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Describe time varying Maxwell's equations and their applications in electromagnetic problems
2. Interpret electric and magnetic field with the help of associated laws
3. Solve simple electrostatic and magnetic boundary conditions
4. Determine the relationship between time varying electric and magnetic fields and electromotive force
5. Solve electromagnetic problems with the help of mathematical tools

Unit 01 : Introduction (06 Hrs)

Sources and effects of Electro-Magnetic Fields, Scalar and vector, Unit vector, Mathematical operations of Vector, Scalar and vector fields, Different Co-ordinate System, Operator Del, Physical interpretation of gradient, divergence and curl, Conversion between coordinate system, Expression for gradient, divergence and curl in three coordinate system.

Unit 02 : Basic Electrostatics (06 Hrs)

Coulomb's law, Electric field, Electric Field Intensity (EFI), EFI due to - point charge, line charge, surface charge and volume charge, Electric displacement, Electric flux density, Gauss's law (scalar and vector form), Applications of Gauss law, Electric field due to – point charge, infinite long straight conductor and infinite plane sheet of charge, Divergence theorem, Stoke's theorem.

Unit 03 : Applied Electrostatics (06 Hrs)

Electric Potential, Relationship between E and V, Equipotential surfaces, Electric dipole and flux lines, Electric field due to dipole, Energy density in electrostatic field, Energy stored in terms of D and E, Convection and Conduction currents, Current and current density, Continuity equation for current, Poisson's and Laplace's equations, Capacitor and its capacitance, Parallel plate capacitor, Capacitors with multiple dielectrics, Spherical capacitor, Coaxial capacitor.

Unit 04 : Magnetostatics and Applications (06 Hrs)

Magnetic flux density, Magnetic field intensity (MFI), Magnetic permeability, Biot-Savart's law, Applications of Biot-Savart's law, MFI due to - infinite long straight filament, finite length element, on the axis of circular loop, Ampere's Circuital law, Field due to – infinite line current, coaxial cable, uniform current sheet density, Magnetic flux density, Scalar magnetic potential, Vector magnetic potential, Poisson's Equations for Magnetostatic field, Derivations of Biot-Savart law and Ampere's law based on magnetic potential, Forces due to magnetic field, Magnetic dipole.

Unit 05 : Boundary Conditions and Analysis. (06 Hrs)

Conductors, Ohm's law employing mobility, Dielectrics, Polarization in Dielectrics, Dielectric constants and strength, Relaxation time, Boundary conditions : Dielectric-Dielectric boundary conditions, Conductor – Dielectric boundary conditions, Conductor – Free space boundary conditions, Boundary conditions for Magnetostatic fields

Unit 06 : Time Varying Fields and Maxwell's equations (06 Hrs)

Faraday's law, Transformer and motional EMFs – stationary loop in time varying B field, moving loop in static B field and moving loop in time varying field, Displacement current, Maxwell's equations in point form and integral form, Power and Poynting theorem, Time varying potentials, Time Harmonic Field, Maxwell's equations in point form and integral form for harmonic field, Concept of uniform plane wave.

Text Books:

[T1] W. H. Hayt and J. A. Buck, "Engineering Electromagnetics", Tata McGraw Hill

[T2] Mathew Sadiku, "Elements of Electromagnetics", Oxford University Press

Reference Books:

[R1] R. K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill

[R2] Liang Chi Shen, Jin Au Kong, Amalendu Patnaik, "Engineering Electromagnetics", CENGAGE Learning

[R3] K. B. Madhu Sahu, "Electromagnetic Fields", SciTech Publication

[R4] N. N. Rao, " Elements of Engineering Electromagnetics", Pearson Education

[R5] Edminister J. A., " Electromagnetics", Tata McGraw Hill

Unit	Text Books	Reference Books
1	T2	R2, R3, R4
2	T1, T2	R1,R2, R3
3	T1, T2	R2, R3, R4, R5
4	T1, T2	R2, R3
5	T2	R1, R4, R5
6	T1, T2	R2, R3, R4

Elective II : 403144 (C) : EHV AC Transmission

Teaching Scheme	**Credits**	**Examination Scheme [100Marks]**		
Theory : 03 Hr/Week	03	In Sem	:	30 Marks
		End Sem	:	70 Marks

Prerequisite : Fundamental course in Power System

The course aims:-

- To explain the need of EHV and UHV systems.
- To describe the impact of such voltage levels on the environment
- To identify problems encountered with EHV and UHV transmissions
- To describe methods of governance on the line conductor design, line height and phase etc.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Highlight need for EHV ac transmission.
2. Calculate line and ground parameters.
3. Enlist problems encountered in EHV transmission.
4. Describe effect of electric and magnetic field on human being
5. Express issues related to UHV transmission discussed

Unit 01 : EHV ac transmission lines (06 Hrs)

Need for EHV transmission lines, Power handling capacity and line loss, Mechanical considerations in line performance, Vibrations.

Travelling wave equations, transmission reflection attenuation and distortion of travelling waves, transmission and reflection coefficients and examples.

Unit 02 : Calculation of line and ground parameters (06 Hrs)

Resistance of conductors, effect of temperature on overhead conductors, temperature rise of conductors and current carrying capacity, Properties of bundled conductors, Inductance of current carrying single conductor, Inductance of EHV line configurations, Line capacitance calculations

Unit 03 : Voltage gradient of conductors (06 Hrs)

Electrostatic Field of a point charge and its properties, Field of sphere gap, Field of line charges and their properties, charge potential relations for multi-conductor lines, Maximum charge condition on three phase line.

Surface voltage gradient on conductors-single conductor, two conductors and multi-conductor bundle, Maximum surface voltage gradient, Mangoldt formula, design of cylindrical cage for corona gradients

Unit 04 : Electrostatic and magnetic fields of EHV lines (06 Hrs)

Electric shock and threshold currents, Effects of high electrostatic fields on humans, animals and plants, Calculation of electrostatic field of single circuit of three phase line, Profile of electrostatic field of line at ground level.

Electrostatic induction on un-energized circuit of a double circuit line. Insulated ground wire and induced voltage in insulated ground wires.

Magnetic field calculation of horizontal configuration of single circuit of three phase lines, Effects of power frequency magnetic fields on human health.

Unit 05 : Corona and its effects (06 Hrs)

Corona formation, corona inception voltage, visual corona voltage, critical field for corona inception and for visual corona under standard operating condition and conditions other than standard operating conditions.

Power loss due to corona, corona loss formulae, corona current waveform, charge-voltage diagram and corona loss. Audible noise operation and characteristics limits for audible noise, AN measurement and meters, microphone, weighting networks.

Unit 06 : (06 Hrs)

A) **Design of EHV line**

Design of EHV lines based upon steady state limits and transient over voltages, design factors under state. Design examples: steady state limits. Line insulation design based on transient over voltages

B**) Extra high voltage cable transmission**

Classification of cables, Electrical characteristics of EHV Cables, Properties of cable insulation materials.

Text Books:

[T1] Rakosh das Begamudre "Extra high voltage transmission", New Age International publishers

Reference Books:

[R1] S. Rao , "EHV AC and DC Transmission" Khanna publication.

Unit	Text Books	Reference Books
1	T1	R1
2	T1	--
3	T1	--
4	T1	R1
5	T1	R1
6	T1	R1

Elective II : 403144 (D) : Electric and Hybrid Vehicles

Teaching Scheme	Credits	Examination Scheme [100 Marks]
Theory : 03 Hr/Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisite: Basic concept of Batteries, Electrical motors, Power electronic conversion

Course Objective: The course aims:-

- To make students aware the need and importance of Electric, Hybrid Electric Vehicles and Fuel cell vehicle.
- To differentiate and analyze the various energy storage devices and battery charging and management systems.
- To impart knowledge about architecture and performance of Electric and Hybrid Vehicles
- To classify the different drives and controls used in electric vehicles.

Course Outcome: Upon successful completion of this course, the students will be able to:-

1. Review history, Social and environmental importance of Hybrid and Electric vehicles.
2. Describe the performance and selection of energy storage systems and Analyze battery management system.
3. Distinguish between the performance and architecture of various drive trains.
4. Describe the different Instrumentation and Control used for electric vehicles.
5. Differentiate between Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid energy systems concepts.

Unit 01 : Introduction (05 Hrs)

Conventional Vehicle: Basic of Vehicle performance, vehicle power source characterization, transmission characterization. Need and importance of transportation development.
History of Electric Vehicle, Hybrid Electric Vehicle and Fuel cell Vehicle. Social and environmental importance of Hybrid and Electric vehicles. Impact of modern drive-trains on energy supplies.

Unit 02 : Energy Storage Systems (07 Hrs)

Introduction to energy storage requirements in Hybrid and Electric vehicles, battery-based energy storage and its analysis, Fuel cell based energy storage and its analysis, Ultra capacitor based energy storage and its analysis, flywheel based energy storage and its analysis.
Hybridization of energy sources for Hybrid and Electric vehicle: - Hybridization of drive trains in HEVs, Hybridization of energy storage in EVs.
Selection of energy storage technology.

Unit 03 : Battery charging and Management systems (06 Hrs)

Introduction, charging algorithm, balancing method for battery pack charging.
Battery management system representation: - battery module, measurement unit block, battery equalization balancing unit, MCU estimation unit, display unit, fault warning block.
SoC and SoH, estimation of SoC, battery balancing, Thermal monitoring of Battery unit.

Unit 04 : Hybrid and Electric vehicles (05 Hrs)

Electric vehicles: - Components, configuration, performance, tractive efforts in normal driving, Advantages and challenges in EV design.
Hybrid Electric vehicles: - Concept and architecture of HEV drive train (Series, parallel and series-parallel).Energy consumption of EV and HEV

Unit 05 : Drives and control systems (07 Hrs)

Drives: - Application of BLDC drives and Switched reluctance motor drive for HEV and EV, performance characteristics of drives.

Instrumentation and control system related to Hybrid and Electric vehicles, speed control, acceleration characteristics, Electric steering, motion control, braking mechanism, Vehicle tracking through GPS, over speed indicating systems, Auto-parking systems

Unit 06 : Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid energy systems (06 Hrs)

Vehicle to Home(V2H): PHEV control Strategies to V2H applications, V2H with demand response.

Vehicle to Vehicle(V2V): - Concept and structure of EV aggregator, control method for EV aggregator for dispatching a fleet of EV.

Vehicle to Grid(V2G): - planning of V2G infrastructure in the smart grid, ancillary services provided by V2G, cost emission optimization.

Text Books:

[T1] James Larminie and John Lowry, "Electrical Vehicle", John Wiley and Sons, 2012.

[T2] Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles", SAE InternationalPublisher**.**

[T3] K T Chau, "Energy Systems for Electric and Hybrid Vehicles", The institution of Engineering and Technology Publication

[T4] D.A.J Rand, R Woods, R M Dell, "Batteries for Electric Vehicles", Research studies press Ltd, New York, John Willey and Sons

[T5] Electric and Hybrid Vehicles-Design Fundamentals, CRC press

[T6] Mark Warner, The Electric Vehicle Conversion handbook –HP Books, 2011.

Reference Books:

[R1] Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design", CRC Press, 2009.

[R2] Junwei Lu, Jahangir Hossain,"Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", IET Digital Library.

[R3] "Automobile Electrical and Electronic systems", Tom Denton, SAE International publications.

[R4] "Automotive handbook 5th edition", Robert Bosch, SAE international publication.

Unit	Text Books	Reference Books
1	T1,T2,T3, T4, T5	R1
2	T1,T2,T3, T4, T5	R1, R3
3	T2,T3,T4	R1
4	T1,T2,T5	R1
5	T1,T2,T5	R1
6	T3	R2

Elective II : 403144 (E) : Special Purpose Machines

Teaching Scheme	**Credits**	**Examination Scheme [100 Marks]**		
Theory : 03Hr/Week	03	In Sem	:	30 Marks
		End Sem	:	70 Marks

Prerequisite:

- Basic concepts of different electric motors
- Laws related to energy conversion in electrical machines
- Knowhow of D-Q axis theory related to electrical machines

Course Objective: The course aims:-

1. To explain operation and performance of synchronous reluctance motors.
2. To describe operation and performance of stepping motors.
3. To elaborate operation and performance of switched reluctance motors.
4. To familiarize with operation and performance of permanent magnet brushless D.C. motors.
5. To illustrate operation and performance of permanent magnet synchronous motors.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Reproduce fundamentals of magnetic circuits
2. Reproduce principal of operation of PMSM, Stepper motor, SRM, Switch reluctance and linear motors.
3. Derive basic transformations used in machine modeling and control
4. Develop torque speed and performance characteristics of above motors
5. Enlist application of above motors
6. Demonstrate various control strategies.

Unit 01 : Generalised Machine Theory (06 Hrs)

Energy in singly excited magnetic field systems, determination of magnetic force and torque from energy. Determination of magnetic force and torque from co-energy, Forces and torques in systems with permanent magnets. MMF of distributed winding, Magnetic fields production of EMFs in rotating machines.

Unit 02 : Permanent Magnet Synchronous and brushless D.C. Motor Drives (06 Hrs)

Synchronous machines with PMs, machine configurations. Types of PM synchronous machines Sinusoidal and Trapezoidal. EMF and torque equations Torque speed characteristics Concept of electronic commutation, Comparative analysis of sinusoidal and trapezoidal motor operations. Applications

Unit 03 : Control of PMSM Machine (06 Hrs)

abc-αβ and αβ-dq transformations, significance in machine modelling, Mathematical Model of PMSM (Sinusoidal), Basics of Field Oriented Control (FOC), Control Strategies: constant torque angle, unity power factor.

Unit 04 : Reluctance Motor (06 Hrs)

Principle of operation and construction of Switch Reluctance motor, Selection of poles and pole arcs, Static and dynamics Torque production, Power flow, effects of saturation, Performance, Torque speed characteristics, Synchronous Reluctance, Constructional features; axial and radial air gap motors; operating principle; reluctance torque; phasor diagram; motor characteristics Introduction to control of Reluctance Drive. Applications.

Unit 05 : Stepper Motor (06 Hrs)

Construction and operation of stepper motor, hybrid, Variable Reluctance and Permanent magnet, characteristics of stepper motor; Static and dynamics characteristics, theory of torque production, figures of merit; Concepts of lead angles , micro stepping , Applications selection of motor.

Unit 06 : Linear Electrical Machines (06 Hrs)

Introduction to linear electric machines. Types of linear induction motors, Constructional details of linear induction motor, Operation of linear induction motor. Performance specifications and characteristics Applications.

Text Books:

[T1] K. Venkatratnam, 'Special Electrical Machines', University Press

[T2] A.E. Fitzgerald Charles Kingsley, Stephen Umans, 'Electric Machinery', Tata McGraw Hill Publication

[T3] T.J.E. Miller, 'Brushless Permanent magnet and Reluctance Motor Drives' Clarendon Press, Oxford 1989.

[T4] V. V. Athani, 'Stepper Motors: Fundamentals, Applications and Design', New age International, 1997

Reference Books:

[R1] R Krishnan, 'Permanent Magnet Synchronous and Brushless D.C. Motor Drives' CRC Press.

[R2] Ion Boldea, 'Linear Electric Machines, Drives and maglevs' CRC press

[R3] Ion Boldea S. Nasar, 'Linear Electrical Actuators and Generators', Cambridge University Press.

Unit	Text Books	Reference Books
1	T2	--
2	T1,T3	R1
3	T1	--
4	T1	--
5	T1,T4	--
6	--	R2, R3

403145: Control System II

Teaching Scheme		Credits	Examination Scheme [150 Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			Oral	:	25 Marks
			Term work	:	25 Marks

Prerequisite: Basic concepts of Control System, Transfer Function, Pole zero plot.

Course Objective: The course aims to:-

- Explain the basic digital control system and the concept of sampling and reconstruction.
- Elaborate the concept of state and to be able to represent a system in the state space format.
- Solve the state equation and familiarize with STM and its properties.
- Design a control system using state space techniques including state feedback control and full order observer.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Recognize the importance of digital control system.
2. Derive pulse transfer function.
3. Analyze digital controllers.
4. Convert system in state space format.
5. Solve state equation.
6. Design observer for system.

Unit 01 : Digital Control System (06 Hrs)

Introduction, Configuration of the basic digital control system. Advantages and limitations of digital control; data conversion and quantization, Sampling and Reconstruction processes, Shannon's Sampling theorem, practical aspects of choice of sampling rate. Zero order hold (ZOH) and it's transfer function, Basic concepts and transfer function of first order hold.

Unit 02 : Z-transform and Pulse-transfer-function (06 Hrs)

Review of z-transform, Inverse z-transform, difference equations and solution using z transform method. Pulse transfer function and Z-transfer function, General procedure for obtaining Pulse-transfer-function, pulse transfer function of ZOH.

Unit 03 : Stability Analysis (06 Hrs)

Sampled data closed loop systems, characteristic equation, causality and physical realizability of discrete data system, realization of digital controller by digital programming, direct digital programming, cascade digital programming, parallel digital programming. Mapping between S-plane and Z-plane, stability analysis of closed loop system in z-plane using Jury's test, Bilinear Transformation.

Unit 04 : Introduction to state space analysis (06 Hrs)

Important definitions – state, state variable, state vector, state space, state equation, output equation. State space representation for electrical and mechanical system, n^{th} order differential equation and transfer function. Conversion of transfer function to state model and vice versa. State model of armature control DC motor

Unit 05 : Solution of state equations (06 Hrs)

Concept of diagonalization, eigen values, eigenvectors, diagonalization of system matrices with distinct and repeated eigen values, Vandermonde matrix.

Solution of homogeneous and non-homogeneous state equation in standard form, state transition matrix, its properties, Evaluation of STM using Laplace transform method and infinite series method Cayley Hamilton theorem.

Unit 06 : Design of Control System Using State Space Technique: (06 Hrs)

Concept of controllability and observability, controllability and observability Tests, condition for controllability and observability from the system matrices in Canonical form, Jordan canonical form, effect of pole zero cancellation on the controllability and observability of the system, duality property. Pole placement design by state variable feedback. Necessity of an observer, design of full order observer.

Guidelines for Instructor's Manual

Instructor's Manual should contain following related to every experiment –

- Theory related to the experiment.
- Connection diagram /circuit diagram.
- Basic MATLAB instructions for control system/ Simulink basics.
- Observation table/ Expected simulation results.
- Sample calculations for one/two reading.
- Result table.

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

- Theory related to the experiment.
- Circuit diagram/Simulink diagram/MATLAB program.
- Observation table/ simulation results.
- Sample calculations for one/two reading.
- Result table, Conclusion.
- Few short questions related to the experiment.

Guidelines for Laboratory Conduction

- Assessment must be based on understanding of theory, attentiveness during practical session.
- Assessment should be done how efficiently student is able to perform experiment/simulation and get the results.
- Understanding fundamentals and objective of experiment, timely submission of journal.

List of Experiments

Any 8 experiments out of the list given below:

1. Plotting of discrete time wave forms a) sin, b)Unit step c) Exponential
2. Effect of sampling and verification of sampling theorem
3. Software programming for determination of STM of Discrete Time system.
4. Design and analysis of digital position control system.
5. Software programming for determination of state space representation for given transfer function and vice versa.
6. Check for observability and controllability in MATLAB
7. Verify State Feedback control using pole placement.
8. Convert a continuous time system to digital control system and check response using software.
9. Design state observer and validate it by software.
10. Software programming for determination of STM.

Text Books:

[T1] K. Ogata, “Discrete Time Control System”, 2nd Edition, PHI Learning Pvt. Ltd. 2009
[T2] Benjamin C. Kuo “Digital Control System”, Prentice Hall of India Pvt. Ltd.
[T3] J. Nagrath, M. Gopal “Control System Engineering”, 5th Edition. New Age International Publishers
[T4] R.Anandanatarajan and P.Ramesh Babu “Control System Engineering”,4th Edition, SCITECH Publications, India Pvt. Ltd.

Reference Books:

[R1] K. Ogata, “Modern Control Engineering”, Prentice Hall of India Pvt. Ltd.
[R2] M. Gopal, “Digital Control and State Variable Methods”, Tata McGraw-Hill.
[R3] M. N. Bandyopadhyay, “Control Engineering – Theory and Practice”, Prentice Hall of India Ltd. Delhi.

Unit	Text Books	Reference Books
1	T1,T2	R1,R2
2	T1,T2	R2,R3
3	T1,T2	R2
4	T3, T4	R1, R3
5	T3, T4	R1, R3
6	T3, T4	R1, R3

403146 : Project I

Teaching Scheme	Credits	Examination Scheme [50 Marks]
Tutorial : 02 Hr/Week	02	Oral : 50 Marks

The student shall take up a project in the field closely related to Electrical Engineering. Preferably, group of 3/4 students should be formed for project work.

The project work should be based on the knowledge acquired by the student during the graduation and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project work in this semester is an integral part of the complete project. In this, the student shall complete the partial work of the project which will consists of problem statement, literature review, project overview and scheme of implementation. As a part of the progress report of project work, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic.

Guidelines for VIIth Semester for Project work:

1. To identify the problems in industry and society.
2. Perform Literature survey on the specific chosen topic through research papers, Journals, books etc. and market survey if required.
3. To narrow down the area taking into consideration his/her strength and interest. The nature of project can be analytical, simulation, experimentation, design and validation.
4. Define problem, objectives, scope and its outcomes.
5. Design scheme of implementation of project.
6. Data collection, simulation, design, hardware if any, needs to be completed.
7. Presentation based on partially completed work.
8. Submission of report based on the work carried out.
9. Student should maintain Project Work Book.

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Audit Course V (A) : 403152: Hydro Energy Systems

Teaching Scheme			**Examination Schemes: Audit (P/F)**
Theory	:	02 Hr/Week	Written / MCQ / Term paper
Field visit	:	1 Day	

Course Objectives:

- To elaborate various hydro electric generators
- To be familiar with basic operation and various elements of hydro electric systems

Course Outcomes:

On completion of the course, students will be able to:-

- Explain and differentiate various types of hydro electric generators; pico, micro and small hydro

Description:

The following topics may be broadly covered in the classroom. The course will introduce the basics of: hydro energy, availability, introduction to hydraulic machines, turbines, basics of design of hydro electric generators, pico, micro and small hydro, grid interaction, advantages and limitations of the technology, environmental impact, and introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The site visit will be organized to understand the basic operation and system elements.

Details:

- Energy in water
- Basic hydro energy conversion
- Types of turbines and their applications
- Decentralized hydroelectric plants
- Pico, Micro, small and large hydroelectric power plants
- Energy conversion calculations
- Hydro turbine basics and design
- Generator designs for hydro power
- Controllers for hydroelectric power
- Site requirements for hydro power
- Grid integration of micro-hydro
- Operation and maintenance of hydro power plants
- Financial modeling of hydro power
- Software tools for simulation, validation and economics of hydro power
- Environmental impact of various capacity hydroelectric plants
- Manufacturing and assembly
- Quality assurance and standards
- Standards and certification for hydroelectric power plants

Field Trip:

- Visit to Pico, Micro or Small hydroelectric plant

Audit Course V (B) : 403152
Foreign language- German

Teaching Scheme	**Examination Schemes: Audit (P/F)**
Theory : 02 Hr/Week	Written / MCQ / Term paper

Course Objectives:

- To meet the needs of ever growing industry with respect to language support
- To get introduced to German society and culture through language

Course Outcomes:

On completion of the course, students will be able to:-

- Comprehend everyday expressions and very simple sentences
- Read, write, listen and grasp German Language
- Develop interest to pursue professional German language

Description:

On a professional level, speaking and understanding another language opens many career opportunities. Knowing more than one language enhances employment opportunities in business, teaching, technology, communications, social service, etc.

In an increasingly globalized world, knowledge of German gives students access to the language, culture, and marketplace of few leading nations.

Speaking German gives significant advantages in the world of business since many companies nowadays would choose a competent German speaker over an equally qualified candidate for a job. A proficiency in German prepares you to function productively on behalf of a multinational employer who wants to capitalize on business.

Course Contents:

- Introduction to alphabets, numbers, months, days of the week and time of the day
- Pronouns, Modal and normal verbs, W/V questions
- Bestimmt, Unbestimmt Artikel, Akkusative and Akkusative prepositions
- Hobbies and Freizeit activities, Perfekt tense, basic adjectives and conjunctions.

References:

- Netzwerk Deutsch als Fremdsprache A1, Langenscheidt, First Indian Edition 2015
- www.dw.de

403147: Switchgear and Protection

Teaching Scheme		Credits	Examination Scheme [175Marks]	
Theory	: 3 Hrs./Week	03	In Sem	: 30 Marks
Practical	: 2 Hrs./Week	01	End Sem	: 70 Marks
			Oral	: 25 Marks
			Term work	: 50 Marks

Prerequisite:

- Different type of faults in power system
- Various switchgears and their use in substation
- Principle and working of rotating machines and transformer with vector groups

Course Objective: The course aims to:-

1. Acquaint about construction and working principle of different types of HVCBs
2. Elaborate the Need of protective Relaying and operating principles of different types of relays.
3. Explain different type of faults in transformer, alternator and 3 phase Induction motor and various protective schemes related to them.
4. Impart knowledge about transmission line protection schemes and characteristics of different types of distance relays

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Describe arc interruption methods in circuit breaker.
2. Derive expression for restriking voltage and RRRV in circuit breaker
3. Explain construction and working of different high voltage circuit breakers such as ABCB, SF_6 CB, and VCB.
4. Classify and Describe different type of relays such as over current relay, Reverse power relay, directional over current relay, Differential relay, Distance relay, Static relay and numerical relay
5. Describe various protection schemes used for transformer, alternator and busbar
6. Describe transmission line protection schemes.

Unit 01 : Fundamentals of protective relaying (08 Hrs)

Need for protective system, nature and causes of fault, types of faults, effects of faults, evolution of protective relaying, classification of relays, zones of protection, primary and backup protection, essential qualities of protective relaying. Trip circuit of circuit breaker, zone of protection. Various basic operating principles of protection- over current, (current graded and time graded), directional over current, differential, distance, induction type relay, torque equation in induction type relay, current and time setting in induction relay, Numericals on TSM , PSM and operating time of relay

Unit 02 : Fundamentals of arc interruption (06 Hrs)

Ionization of gases, deionization, Electric arc formation , Current interruption in AC circuit breaker, high and low resistance principles, arc interruption theories, arc voltage, recovery voltage, derivation and definition of restriking voltage and RRRV, current chopping, interruption of capacitive current, resistance switching, Numerical on RRRV, current chopping and resistance switching.

Unit 03 : Circuit Breaker (05 Hrs)

Different ratings of circuit breaker (like rated voltage, rated current, rated frequency, rated breaking capacity – symmetrical and unsymmetrical breaking, making capacity, rated interrupting duties, rated operating sequence, short time rating). Classification of high voltage circuit breaker. Working and constructional features of ACB, SF_6 VCB- advantages, disadvantages and applications. Auto reclosing.

Unit 04 : (05 Hrs)

A) Static and Digital Relaying

Overview of Static relay, block diagram, operating principal, merits and demerits of static relay. Numerical Relays :-Introduction and block diagram of numerical relay, Sampling theorem, Anti –Aliasing Filter, Block diagram of PMU

B) 3 Phase Induction Motor Protection

Abnormal conditions and causes of failures in 3 phase Induction motor, single phasing protection, Overload protection, Short circuit protection.

Unit 05 : (06 Hrs)

A) Transformer Protection

Types of faults in transformer, Percentage differential protection in transformers, Restricted E/F protection, incipient faults, Buchholz relay, protection against over fluxing, protection against inrush current,

B) Alternator Protection

Various faults in Alternator, abnormal operating conditions- stator faults, longitudinal percentage differential scheme and transverse percentage differential scheme. Rotor faults- abnormal operating conditions, inter turn fault, unbalance loading, over speeding, loss of excitation, protection against loss of excitation using offset Mho relay, loss of prime mover.

Unit 06 : Transmission line protection (06 Hrs)

Over current protection for feeder using directional and non directional over current relays, Introduction to distance protection, impedance relay, reactance relay, mho relay and Quadrilateral Relays, Introduction to PLCC, block diagram, advantages, disadvantages, three stepped distance protection, Effect of arc resistance, and power swing on performance of distance relay. Realization of distance relays(impedance, reactance, and mho relay) using numerical relaying algorithm(flowchart, block diagram), Introduction to Wide Area Measurement (WAM) system.

Guidelines for Instructor's Manual

Prepare 3/4 sets of standard experiments. It must contain title of the experiment, Aim, Apparatus

- **Theory:** Brief theory explaining the experiment
- **Circuit / connection diagram** or construction diagram must be drawn either manually using geometrical instruments or using software on A-4 size quality graph paper / plain white paper.
- **Procedure:** Write down step by step procedure to perform the experiment.
- **Specifications of Switchgear:**
- **Observation table:**
- **Graph:**
- **Detailed constructional diagram with nomenclature:**
- **Conclusion:**

Guidelines for Student's Lab Journal

- Students should write the journal in his own hand writing using A4 size both side ruled paper.
- Circuit / Connection diagram or construction diagram must be drawn either manually or using software. [Do not use Photo copy of standard journal] on A4 size blank/graph paper.
- Hand writing must be neat and clean.
- Journal must contain certificate indicating name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal.
- Index must contain sr. number, title of the experiment, page number, and the signature of staff along with date.
- (Use black or blue ink pen for writing.)

Guidelines for Laboratory conduction

- Check whether the MCB / main switch is off.
- Make connections as per circuit diagram. Do not keep loose connection. Get it checked from teacher / Lab Assistant.
- Perform the experiment only in presence of teacher or Lab Assistant.
- After completion of experiment, switch off the MCB / main switch.
- Write the experiment in the journal and get it checked within a week

List of Experiments :

A) Compulsory Experiments

1. Study of switchgear testing kit.
2. Study of bus-bar protection schemes.

B) Minimum 6 Experiments to be performed from the following list:

1. Study of Fuse, MCB and MCCB
2. Testing of MCB and MCCB.
3. Study and testing of contactors.
4. Study and testing of ACB.
5. Study and testing of thermal overload relay for Induction Motor protection.
6. Study and plot Characteristics of IDMT type Induction over current relay
7. Study and plot Characteristics of digital over current relay
8. Percentage differential protection of transformer.
9. Protection of alternator.
10. Protection of Transmission line using Impedance relay
11. Study of various LT switchgears like RCCB, timers.

Industrial Visit:

A compulsory industrial visit to switchgear training centre /or switchgear/relay manufacturing unit/ or 220 kV substation visit and report to be submitted as a part of term-work.

Assignments:

Minimum 3 assignments (at least 4 to 6 questions in each) to be submitted as a part of term-work.

Text Books:

[T1] S. Rao, “Switchgear Protection and Power Systems”, Khanna Publications

[T2] Y. G. Paithankar, S. R. Bhide, “Fundamentals of Power System Protection”, Prentice Hall of India

[T3] Bhavesh Bhalja,R.P. Maheshwari, N.G. Chothani,” Protection and Switchgear”, Oxford University Press, 2011 Edition.

[T4] J.B.Gupta “ Switchgear and Protection”, S.K. Kataria and Sons.

Reference Books:

[R1] Badri Ram, D. N. Vishwakarma, “Power System Protection and Switchgear”, Tata McGraw Hill Publishing Co. Ltd.

[R2] J Lewis Blackburn , “Protective Relaying- Principles and Applications”, Dekker Publications.

[R3] Prof. Dr S.A. Soman, IIT Mumbai, A Web course on “Digital Protection of power System” **http://www.cdeep.iitb.ac.in/nptel/Electrical%20Engineering/Power%20System%20Protection/Course_home_L27.html**

[R4] A.G. Phadke, J.S. Thorp ,Computer relaying for Power System , Research Studies Press LTD, England.(John Willy and Sons Inc New York)

[R5] Mason C.R., “Art and Science of Protective Relaying”, Wiley Eastern Limited.

[R6] Arun Ingole, “Switchgear and Protection”, Pearson.

Unit	Text Books	Reference Books
1	T1,T2,T4	R1, R2, R6
2	T1,T3,T4	R1, R6
3	T1,T4	R1
4	T2,T3,T4	R3, R4, R6
5	T1	R5
6	T1,T4	R2, R5

403148: Power Electronic Controlled Drives

Teaching Scheme		Credits	Examination Scheme [175 Marks]	
Theory	: 4 Hrs./Week	04	In Sem	: 30 Marks
Practical	: 2 Hrs./Week	01	End Sem	: 70 Marks
			PR	: 50 Marks
			Term work	: 25 Marks

Prerequisite:
1. Construction, working and characteristic of different electrical motors and soft starting methods.
2. Power Electronic Applications such as converter, inverter, chopper etc.
3. Basic concept of control system

Course Objective: The course aims to
- To understand motor load dynamics.
- To analyze the operation of the converter fed and chopper fed dc drives.
- To elaborate braking methods of D.C. and Induction motor drive.
- To explain vector control of induction motor.
- To differentiate synchronous and BLDC motor drive.
- To identify classes and duty of motor.
- To describe the modes of operation of drive in various applications.

Course Outcome: Upon successful completion of this course, the students will be able to

1. Explain motor load dynamics and multi quadrant operation of drives
2. Analyze operation of converter fed and chopper fed DC drives.
3. Describe braking methods of D.C. and induction motor drive.
4. Explain vector control for induction motor drives
5. Describe synchronous motor drive.
6. Identify classes and duty cycles of motor and applications of drives in industries.

Unit 01 : Electrical Drives (08 Hrs)

A. Definition, Advantages of electrical drives, Components of Electric drive system, Types of Electrical Drives (DC and AC).

B. Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components, Nature and classification of Load. Constant Power operation of a Drive. Steady state stability, Numerical based on motor load dynamics.

Unit 02 : DC Motor Drives (08 Hrs)

A. Braking methods: Rheostatic, Plugging, and Regenerative. Closed loop control of drives: current limit control, torque control and speed control.

B. Single phase and three phase fully controlled converter drives and performance of converter fed separately excited DC Motor for speed control operations.

Chopper controlled drives for separately excited and series DC Motor operations.

Numerical based on above. Closed loop speed control of DC motor below and above base speed.

Unit 03 : Induction motor Drives I (08 Hrs)

Braking methods: DC Dynamic Braking, AC Rheostatic braking, Plugging, Regenerative Braking, V/f control and comparison with stator voltage control, voltage source inverter (VSI) control, Steady State Analysis. Current source inverter (CSI) control-open and closed loop, Regenerative braking and multiquadrant operation of Induction motor drives, relative merits and demerits of VSI and CSI for induction motor drives, Numerical on VSI and CSI fed I.M. drives

Unit 04 : Induction Motor Drives II (08 Hrs)

A. Principle of vector control, Block diagram of Vector control of induction motor. Servo mechanism in drives and block diagram for position control (Descriptive treatment only).
B. Thermal model of motor for heating and cooling, classes of motor duty, types of enclosures for motor.

Unit 05 : Synchronous motor Drives (08 Hrs)

Types of motor, cylindrical rotor wound field motor, equivalent circuit, speed torque characteristics and effect of power factor, salient pole wound field motor, phasor diagram, simple numerical based on above, closed loop speed control of self controlled synchronous motor drives fed from VSI and CSI.
BLDC drives, block diagram and speed torque characteristics.

Unit 06 : Industrial application (08 Hrs)

A. Specific requirement and choice of drives for following applications.
1. Machine tools
2. Textile mills
3. Steel rolling mills
3. Sugar mills
4. Traction drives
5. Crane and hoist drives
6. Solar and battery powered drives

Guidelines for Instructor's Manual

- Title and circuit diagram of power electronic controlled drives/ electrical machine circuit.
- Working operation and output characteristics / output waveforms of power electronic switching device /converter circuit used to control the electric motor.
- Procedure to carry out the experiment

Guidelines for Student's Lab Journal

- Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit and expected machine performance with speed torque characteristics.
- Equipments along with the specifications needed to carry out the experiment.
- Circuit diagram, observation table, calculations must be written on left side of the journal and aim, theory related to experiment and procedure must be written on right side.
- Analyse and interpret the experimental results and write the conclusions appropriately.

Guidelines for Laboratory conduction

- Each group in the lab should have not more than three students.
- All the students in the group must do the connections and perform the practical under the guidance of the staff member.
- Staff member has to check the result of all the groups.

List of Experiments: Minimum eight experiments are to be performed out of the list mentioned as below:

GROUP A: Any FIVE Experiment (Hardware)

1. Study of Electrical braking of D.C. Shunt motor (Rheostatic, Plugging).
2. Study speed control characteristics of single phase fully converter fed separately excited D.C. motor
3. Study speed control characteristics of 3-ph fully converter fed separately excited D.C. motor
4. Study of Chopper fed D.C. series/separately motor speed control characteristics.
5. Study of electrical braking of 3 phases Induction Motor (DC Dynamic Braking, Plugging).
6. Study of VSI fed 3 phase Induction motor (using V/f control PWM inverter) speed control characteristics.
7. Study of Solid state stator voltage control of 3 phase Induction motor (Using AC voltage Regulator).
8. Study of constant torque and constant power characteristic of induction motor.

GROUP B: Any THREE Experiment (Software)

1. Simulation of starting characteristics of D.C. motor.
2. Simulation of starting characteristics of 3 phase Induction motor.
3. Study of Closed loop speed control of separately excited D.C. motor/ Induction Motor.
4. Simulation of an electric drive system for steady state and transient analysis.
5. Simulation of closed loop control of synchronous motor
6. Simulation of chopper controlled DC series motor.

Industrial Visit:

Minimum one industrial visit must be organized for drives application in industry such as railways, sugar mill, machine shop, textile mill, paper mill etc.

Text Books:

[T1] G. K. Dubey, “Fundamentals of Electric Drives”, 2nd Edition, Narosa Publishing House
[T2] N. K. De, P. K. Sen, “Electric Drives”, Prentice Hall of India Eastern Economy Edition
[T3] S. K. Pillai, “Analysis of Thyristor Power Conditioned Motors”, University Press
[T4] R. Krishnan, “Electric Motor Drives – Modeling Analysis and Control”, PHI India
[T5] G.K. Dubey, “Power Semiconductor controlled drives”, PHI publication

Reference Books:

[R1] B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education
[R2] Malcolm Barnes, “Practical Variable Speed Drives and Power Electronics”, Elsevier Newnes Publications
[R3] V. Subrahmanyam, “Electric Drives: Concepts and Application”, Tata Mc-Graw Hill (An imprint of Elsevier)
[R4] M.D. Singh and Khanchandani “Power Electronics”, Tata Mc-Graw Hill
[R5] Austin Huges, “Electrical motor and drives: Fundamental, types and applications”, Heinemann Newnes, London
[R6] Tyagi MATLAB for engineers oxford (Indian Edition)

Unit	Text Books	Reference Books
1	T1	R3
2	T1,T5	R2,R4
3	T1,T4	R1,R5
4	T1,T2,T5	R1,R2
5	T1,T3,T5	R1,R6
6	T1,T2	R3,R5

Elective –III : 403149 (A): High Voltage Engineering

Teaching Scheme		Credits	Examination Scheme [150 Marks]	
Theory	: 03 Hrs./Week	03	In Sem	: 30 Marks
Practical	: 02 Hrs./Week	01	End Sem	: 70 Marks
			Oral	: 25 Marks
			Term work	: 25 Marks

Prerequisite: Atomic and molecular structure of gaseous and solid materials, basic properties of conductors and insulators, knowledge of material science.

Course Objective: The course aims to:-

- To enable students to know and compare the various processes of breakdown in solid, liquid and gaseous dielectric materials
- To enable students understand and apply various methods of generation and measurement of DC, AC, impulse voltage and current.
- To enable students to know the charge formation and separation phenomenon in clouds, causes of overvoltage and lightening phenomenon
- To develop ability among learners to execute testing on various high voltage equipments as per standards
- To introduce students to the design, layout, safety precautions, earthing, and shielding of HV laboratory.

Course Outcome: Upon successful completion of this course, the students will be able to

1. Identify, describe and analyze the breakdown theories of solid, liquid and gaseous materials
2. Describe as well as use different methods of generation of high AC, DC, impulse voltage and current.
3. Demonstrate and use different methods of measurement of high AC, DC, impulse voltage and current.
4. Identify the occurrence of overvoltage and to provide remedial solutions
5. Demonstrate an ability to carry out different tests on high voltage equipment and devices as well as ability to design the high voltage laboratory with all safety measures

Unit 01 : Breakdown in Gases (06 Hrs)

Ionization process in gas, Townsend's Theory, current growth equation in presence of primary and secondary ionization processes, Townsend's breakdown criterion, primary and secondary ionization coefficients, limitations of Townsend's theory, Streamer mechanism of breakdown, Paschen's Law and its limitations, Corona discharges for point plane electrode combination with positive and negative pulse application, time lag and factors on which time lag depends. (Numerical on Townsend's theory and Paschen's law).

Unit 02 : **(06 Hrs)**

1. **Breakdown in Liquid Dielectrics:** Pure and commercial liquids, Different breakdown theories: Breakdown in Pure liquid and breakdown in commercial liquids: Suspended Particle theory, Cavitations and bubble theory, Thermal mechanism of breakdown and Stressed Oil volume theory

2. Breakdown in Solid Dielectrics: Intrinsic breakdown: electronic breakdown, avalanche or streamer breakdown, electro-mechanical breakdown, thermal breakdown, treeing and tracking phenomenon, Chemical and electrochemical breakdown, Partial discharge(Internal discharge),Composite dielectric material, Properties of composite dielectrics, breakdown in composite dielectrics. (Numerical on theories of liquid and solid dielectric materials)

Unit 03 : Generation of High Voltages and Current **(06 Hrs)**

a)Generation of high ac voltages-Cascading of transformers, series and parallel resonance system, Tesla coil

b)Generation of impulse voltages and current-Impulse voltage definition, wave front and wave tail time, Multistage impulse generator, Modified Marx circuit, Tripping and control of impulse generators, Generation of high impulse current

Unit 04 : Measurement of High Voltage and HighCurrents: **(06 Hrs)**

Sphere gap voltmeter, electrostatic volt meter, generating voltmeter, peak reading voltmeter, resistive, capacitive and mixed potential divider , capacitance voltage transformer, cathode ray oscilloscope for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements. Measurement of high power frequency a.c. using current transformer with electro-optical signal converter, Radio interference measurements.

Unit 05 : Lightning and Switching Over Voltages **(06 Hrs)**

Causes of over voltages, lightning phenomenon, Different types of lightening strokes and mechanisms of lightening strokes, Charge separation theories, Wilson theory, Simpson theory, Reynolds and Mason theory, Over voltage due to switching surges and methods to minimize switching surges. Statistical approach of insulation coordination

Unit 06 : High Voltage Testing of Electrical Apparatus and H V Laboratories: **(06 Hrs)**

a)Testing of insulators and bushings, Power capacitors and cables testing, testing of surge arresters.

b) Design, planning and layout of High Voltage laboratory:-Classification and layouts, earthing and shielding of H.V. laboratories.

Guidelines for Instructor's Manual

The Instructor's Manual should contain following related to every experiment

- Brief theory related to the experiment.
- Circuit diagram and apparatus with their detail specification as per IS code.
- Students should be encouraged to visit industries/HV laboratories/HV installations.
- Students should be encouraged to use virtual labs.
- Few short questions related to each practical.

Assignments based on use of IS and IEC

Guidelines for Student's Lab Journal

The Students lab journal should contain:

- Brief theory related to the experiment.
- Circuit diagram and apparatus with their detail specification as per IS code.
- Observations, result tables and proper inferences/ conclusion from each experiment conducted.
- Reports on visit to industries/HV laboratories/HV installations.
- Simulations and print outs of use of virtual labs.
- Few short questions and answers related to each practical.
- Assignments based on use of IS and IEC.

Guidelines for Laboratory conduction

- There should be continuous assessment for the TW.
- Assessment must be based on understanding of theory, attentiveness during practical.
- Session, how efficiently the student is able to do connections and get the results.
- Timely submission of journal.

List of Experiments

1. To find the constants of breakdown equation of transformer oil.(Analytical and graphical method)
2. Measurement of unknown high a.c. voltage using sphere gap
3. To obtain breakdown strength of composite insulation system, and observe the effect of parameter like no. of layers, thickness of layer, effect of interfacing.
4. To find out the breakdown of air in uniform and non uniform field and compare it.
5. To study surface flashover on corrugated porcelain/polymeric insulation system.
6. To understand basic principle of corona and obtain audible and visible corona inception and extinction voltage under non uniform field.
7. To perform experiment on horn gap arrestor and understand arc quenching phenomenon.
8. To observe development of tracks and trees on polymeric insulation system.
9. Parametric analysis of Impulse current generator using virtual Laboratory.
10. To perform experiment on rod gap arrestor.
11. To Study effect of barrier on breakdown voltage of air/ transformer oil.
12. Simulation of lightening and switching impulse voltage generator using any simulation software.
13. To perform various HV insulation tests on cables as per IS.
14. Study of layout /earthing/safety of HV installation /lab in any industry by visit /virtual lab
15. Study of any IS for any power apparatus (Power Transformer/Induction Motor/ Alternator etc)

Industrial Visit: Industrial visit to high voltage equipment manufacturing industry/EHV substation/High Voltage Testing Unit.

Text Books:

[T1] M. S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publication Co. Ltd. New Delhi

[T2] C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd.

Reference Books:

[R1] E. Kuffel, W. S. Zaengl, J. Kuffel, “High Voltage Engineering Fundamentals”, Newnes Publication

[R2] Prof. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, “High Voltage Engineering”, Khanna Publishers, New Delhi

[R3] Ravindra Arora, Wolf Gang Mosch, “High Voltage Insulation Engineering”, New Age International

[R4] High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York and Basel.

[R5] Subir Ray, “An Introduction to High voltage Engineering” PHI Pvt. Ltd. New Delhi

[R6] NPTEL lectures

[R7] IS 731-1971:Porcelain insulator for overhead power lines with nominal voltage > 1000 Volt

[R8] Bushings :IS2099-1986,specification for bushings for A.C. Voltages > 1000 Volts

[R9] Pollution test :IEC 60507-1991 on external and internal insulator

[R10] High voltage test techniques, general definitions and test requirements: IS 2071(part 1) 1993,IEC Pub 60-1(1989)

Unit	**Text Books**	**Reference Books**
1	T1,T2	R1,R2,R3,R6
2	T1,T2	R1,R2,R3,R5,R6
3	T1,T2	R1,R2,R3,R5,R6
4	T1,T2	R1,R2,R3,R4,R5,R6
5	T1,T2	R1,R2,R3,R4,R5,R6
6	T1,T2	R1,R2,R3,R7,R8,R9, R10

Elective –III : 403149 (B): HVDC and FACTS

Teaching Scheme	Credits	Examination Scheme [150 Marks]
Theory : 03Hrs./Week	03	In Sem : 30 Marks
Practical : 02Hrs./Week	01	End Sem : 70 Marks
		Oral : 25Marks
		Term work: : 25 Marks

Prerequisite:

1. Fundamental knowledge of Power Electronics and power controllers
2. Fundamentals of Power system Operation of three phase converters
3. Inverter topologies
3. Operation of VSI

Course Objective: The course aims to:-

- To provide students knowledge about modern trends in Power Transmission Technology
- To make students describe applications of power electronics in the control of power transmission.
- To educate students for utilization of software such as PSCAD, MATLAB for power transmission and control.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Compare HVDC and EHV AC systems for various aspects
2. Reproduce the layout of HVDC system with various components including protective devices
3. Differentiate VSC HVDC and conventional HVDC system
4. Differentiate various types of Power Electronic Controllers
5. Analyze modeling of FACTs Controllers
6. Simulate various controllers and HVDC systems using softwares

Unit 01 : (06 Hrs)

EHVAC versus HVDC transmission, power flow through HVDC link, Graetz circuit, equation for HVDC power flow bridge connection, control of DC voltage and power flow, effects of angle of delay and angle of advance commutation, CIA, CC and CEA control.

Unit 02 : (06 Hrs)

Twelve pulse converter operation, Harmonics in HVDC systems. HVDC system layout and placement of components, HVDC protection, grounding, multi terminal HVDC systems, configurations and types.

Unit 03 : VSC HVDC Technology (06 Hrs)

Introduction to VSC transmission, power transfer characteristics, structure of VSC link, VSC DC system control, HVDC light technology. HVDC plus, introduction, construction, operation and applications to renewable energy sources

Unit 04 : Power Electronic Controllers (06 Hrs)

Basics, Challenges and needs, Review of rectifiers and inverters, back to back converter, dc link converter, static Power converter structures, AC controller based structures, DC link converter topologies, converter output and harmonic control, power converter control.

Unit 05 : Shunt and Series Compensation (06 Hrs)

Operation and control of SVC, STATCOM configuration and control, characteristics and applications of SVC and STATCOM, TCSC layout and modes of operation, layout, operation and characteristics of Static Synchronous Series Compensator (SSSC).

Unit 06 : Unified Power Flow Controller (06 Hrs)

UPFC configuration, steady state operation, control and characteristics, operational constraints of UPFC, Power flow studies in UPFC embedded systems.

Guidelines for Instructor's Manual

- Title and circuit diagram of experiment (block diagram) /power network.
- Working operation and output characteristics / output waveforms of power electronic Controllers/FACTS devices /converter circuit used to control.
- Procedure to carry out the experiment
- For simulation experiments print out of model and simulation results

Guidelines for Student's Lab Journal

- Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit and expected machine performance with speed torque characteristics.
- Equipment along with the specifications needed to carry out the experiment.
- Circuit diagram, observation table, calculations if any.
- Analyse and interpret the experimental results and write the conclusions appropriately.

Guidelines for Laboratory conduction

- Minimum eight experiments are to be performed out of the list mentioned as below:
- Out of which at least two experiments shall be conducted on hardware setups.
- For simulation experiment ready models/demo models can be used. However study should simulate models for different conditions and attached prints of simulation models and test results.
- Term work should be assessed continuously.
- Term work marks are based on quality of work, initiative, timely submission

List of Experiments

Minimum eight experiments are to be performed out of the list mentioned as below:

A) Hardware experiments

1. Study effects of angle of delay and angle of advance commutation, CIA, CC and CEA control on single bridge converter
2. Study of Single Phase Thyristor Control Reactor(A) Study of Voltage and Current Waveforms with different delay angles (B) harmonic analysis (C) Basic control law (D) V-I characteristics
3. Single Phase TCR with fixed capacitor and filter.
4. Complete characteristics of a three phase voltage source converter, constant alpha and extinction angle control.

B) Simulation Experiments

1. Study and simulation of Three phase TCR with and without shunt capacitor
2. Study and simulation of resonance in electrical Power systems
3. Application study of SVC in Power System.
4. Application study of TCSC in Power System
5. Study and simulation of 6 pulse HVDC system
6. Study of 12 pulse or 24 pulse or 48 pulse inverter
7. Application study of DSTATCOM in Power System
8. Study and simulation of Power Flow control in a five bus system using any one of the following FACTS Controllers: (i) SVC (ii) STATCOM (iii) SSSC (iii) UPFC

Industrial Visit: Desirable visit to nearest HVDC substation

Text Books:

[T1] E. Acha, V.A. Agelidis, O.Anaya-lara and TJE Miller, "Power Electronic control in Electrical Systems" Newnes, Oxford.

[T2] J. Arrillaga, "High Voltage Direct Current Transmission" Peter Peregrinus Ltd., London, UK.

[T3] N.G. Hingorani and L.Gyugi, "Understanding FACTS" IEEE Press[Indian Edition], New York.

[T4] J. Arrillaga, Y.H.Liu and N.R.Watson, "Flexible Power Transmission The HVDC Options", John Wiley and sons Ltd., New York.

[T5] Erich Uhlmann, "Power Transmission by Direct Current" Springer International.

Reference Books:

[R1] Yong Hua Song and Allan T Johns, "Flexible ac transmission systems(FACTS), Published by The Institution of Electrical Engineers, London.

[R2] K.R.Padiyar, "FACTS controllers in transmission and Distribution" New Age Publications, New Delhi.

[R3] K.R.Padiyar , "HVDC Power Transmission Systems", New Age Publications, New Delhi, (2nd Edition)

[R4] M.H.Rashid , "Power Electronics Handbook", Academic Press.

[R5] PrabhaKundur, "Power System Stability and Control", McGraw Hill

[R6] S Kamakshaiah, V Kamaraju, "HVDC Transmission", McGraw Hill

Unit	Text Books	Reference Books
1	T2,T4,T5	R3,R6
2	T1, T3	R3, R4,R7
3	T1, T2	R1, R6
4	T2	R5, R8
5	T6	R2
6	T2, T3	R6

Elective –III : 403149 (C) : Digital Control Systems

Teaching Scheme	Credits	Examination Scheme [150 Marks]
Theory : 03 Hrs./Week	03	In Sem : 30 Marks
Practical : 02Hrs./Week	01	End Sem : 70 Marks
		Oral : 25Marks
		Term work : 25 Marks

Prerequisite : Z-Transform, Basics of discrete systems.

Course Objective: The course aims to:-

- Make students elaborate basic concepts of discrete signals and systems.
- Educate students to analyze the stability of discrete systems.
- Explain formulation of state space discrete model and design the digital controllers.
- Elaborate digitize analog controllers using various numerical methods.
- Explore application of the theory of digital control to practical problems.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Analyze digital control system and its stability.
2. Differentiate between various control systems
3. Present system in state space format.
4. Design observer for system.
5. Understand digital controllers
6. Elaborate applications such as digital temperature control and position control

Unit 01 : Discrete systems and Signals (06 Hrs)

Standard discrete test signals, Basic operations on signals. Classification of discrete systems. Detail analysis of frequency aliasing and quantization, Brief review of Sampling theorem, Ideal low pass filter. Transfer function of ZOH, Frequency domain characteristics of ZOH, First order hold, frequency domain characteristics of first order hold.

Unit 02 : State - Space analysis (06 Hrs)

Conversion of Pulse transfer functions to State space model and vice a versa. Solution of LTI Discrete –time state equation; State Transition Matrix (STM) and properties of STM; Computation of STM by Z-transform method, by power series expansion method, by Cayley Hamilton theorem, by Similarity transformation method, Discretization of continuous time state space equation.

Unit 03 : Design using state space (05 Hrs)

Controllability and observability of linear time invariant discrete-data system, Tests for Controllability and observability; Principal of Duality; Effect of pole- zero cancellation; Relationship between controllability, observability and stability. Pole placement design using linear state-feedback.

Unit 04 : Design of State Observers (06 Hrs)

Full order state observer, reduced order state observer, State estimation and full order observer design. Ackermann's formula. Compensator design by the separation principle, State feedback with integral control, State regulator design.

Unit 05 : State space model and digitising analog controllers (07 Hrs)

State space model of digital systems: Transformation of state-space model to various forms (controllable, observable, diagonal and Jordan canonical forms). Numerical approximation of differential equations, Eulers foreword and backward method, Trapezoidal method, Bilinear transformation with frequency warping. Numerical differentiation, Matching step and other response. Pole-zero matching.

Unit 06 : Digital control system applications (0 6 Hrs)

Hybrid system simulation, Computer program structure for simulation of discrete time control of continuous time plant. Digital temperature control, position control, Stepper motor control, Block diagram presentation and control algorithms.

List of Experiments Perform any eight experiments using MATLAB

1. Design and analysis of digital temperature control system
2. Design and analysis of digital position control system.
3. Software programming for determination of STM of DT system.
4. Software programming to design DT system by pole placement through state feedback.
5. Software programming for determination of controllability and observability of DT System.
6. Software programming to observe effect of sampling on response of the system
7. Software programming to observe effect of sampling on stability of DT system.
8. Solution of state equation of L.T.I. systems by the use of digital computer.
9. Digital computer aided difference equation solution.
10. Conversion of continuous time state space model to discrete time state space model

Text Books:

[T1] K. Ogata, "Discrete Time Control System", 2nd Edition, PHI Learning Pvt. Ltd. 2009

[T2] B. C. Kuo, "Digital Control Systems", 2nd Edition, Oxford University Press

[T3] M. Gopal, "Digital Control Engineering", New Age International Publishers

[T4] M. Gopal, "Digital Control and State Variable Methods", 3rd Edition The McGraw Hill Co.

Reference Books:

[R1] Load D. Landau, Gianluca Zito, 'Digital Control Systems: design, Identification and Implementation' Springer.

[R2] Mohammed Santina, Allen Stubberud, Gene Hostetter 'Digital control System Design', Sanders College publishing

[R3] K.J. Astrom, B Wittenmark 'Computer Controlled Systems: Theory and Design' Prentice-Hall Inc New Jersey, 2011 Dover.

Unit	Text Books	Reference Books
1	T2,T3	R3
2	T2,	R3
3	T1,T2	R3
4	T1,T2	R1,R2
5	T1,T3	R1,R2
6	T2,T4	R3

Elective – III : 403149 (D): Intelligent Systems and Applications in Electrical Engineering

Teaching Scheme	**Credits**	**Examination Scheme [150 Marks]**
Theory : 03 Hrs./Week	03	In Sem : 30 Marks
Practical : 02 Hrs./Week	01	End Sem : 70 Marks
		Oral : 25 Marks
		TW : 25 Marks

Prerequisite: Knowledge of MATLAB, C- Programming

Course Objective: The course aims to:-

- To enhance knowledge of intelligence system to carry out power system problems.
- To impart knowledge about Artificial neural network and fuzzy logic programming for electrical engineering applications like load dispatch and load shedding.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Classify neural networks
2. Compare various AI tools
3. Develop algorithms for AI tools
4. Apply AI tools for Applications in electrical engineering

Unit 01 : Introduction to Artificial Neural Network (06 Hrs)

Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Historical Developments. Essentials of Artificial Neural Networks: Artificial Neuron Model, operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures

Unit 02 : Classification Taxonomy of ANN (06 Hrs)

Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules.

Perceptron Models: Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem. Multilayer feed forward Neural Networks

Unit 03 : Memory (06 Hrs)

Associative Memory, Bi-directional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART).

Unit 04 : Introduction to Fuzzy Logic system (06 Hrs)

Fuzzy versus crisp, fuzzy sets: membership function, Basic fuzzy set operations, properties of fuzzy sets, fuzzy relations.

Unit 05 : Fuzzy Control (06 Hrs)

Predicate logic (Interpretation of predicate logic formula, Inference in predicate logic), fuzzy logic (Fuzzy quantifiers, fuzzy Inference), fuzzy rule based system, defuzzification methods

Unit 06 : Introduction to other Intelligent tools (06 Hrs)

Introduction to Genetic Algorithm: biological background, GA operators, selection, encoding, crossover, mutation, chromosome.

Expert System: software architecture, rule base system

List of Experiments
Minimum eight experiments are to be performed out of the list mentioned as below:

[Matlab Programming based experiments.]

1. Write program to evaluate output of any given architecture of neural network with different transfer functions such as linear logsig tanh, threshold function.
2. Verify the fault tolerant nature of neural network by disconnecting few weight link for a given architecture
3. Write program for perceptron learning algorithm.
4. To study some basic neuron models and learning algorithms by using ANN tool
5. Power system failure analysis using ANN tool
6. Predict power factor of four bus system using neural network
7. Predict system analysis for measurements like rms voltage using ANN tool
8. Write supervised and unsupervised ANN program for Signal Frequency Separation using Perceptron
9. Temperature monitoring using fuzzy logic
10. Speed control of DC motor using fuzzy logic
11. Fuzzy logic based washing machine control
12. Fuzzy logic based air conditioner
13. Design of a Fuzzy Multi-Objective Power System Stabilizer via Linear Matrix Inequalities

Text Books:

[T1] Simon Haykin, “Neural Networks: A Comprehensive Foundation”, 2nd Edition, Pearson Education

[T2] S. Rajsekaram, G. A. Vijayalaxmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications”, Practice Hall India

[T3] James A. Anderson, “An Introduction to Neural Networks”, Practice Hall India Publication

[T4] Mohamed H. Hassoun, “Fundamentals of Artificial Neural Network”, Practice Hall India

Reference Books:

[R1] Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, “AI Techniques in Power System”, IEE London, U.K.

[R2] S. N. Sivanandam, S. Sumathi, S. N. Deepa, “Introduction to Neural Network Using MATLAB 6.0”, Tata McGraw Hill

[R3] Jacek Zurada, “Introduction to Artificial Neural Network”, Jaico Publishing House India

Unit	Text Books	Reference Books
1	T1,T2	R1,R2
2	T1,T2	R1,R2
3	T1,T2	R1,R2
4	T2	R1
5	T2	R1
6	T1	R1,R2

Elective – III : 403149 (E): Analog Electronics and Sensing Technology [Open Elective]

Teaching Scheme		Credits	Examination Scheme [150 Marks]	
Theory	: 03 Hrs./Week	03	In Sem	: 30 Marks
Practical	: 02 Hrs./Week	01	End Sem	: 70 Marks
			Oral	: 25 Marks
			TW	: 25 Marks

Course Objective: The course aims to:-

- Study operational amplifiers for various analog operations.
- Understand different types of analog filters and waveform generation techniques.
- Study advance applications such as mux/demux and multipliers.
- Understand various analog sensors for various applications.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Develop various analog circuits using operational amplifiers.
2. Design filters and waveform generators and various signal converter circuits.
3. Find characteristics of sensors used for system monitoring and protection.
4. Interface various position sensors to microcontrollers.
5. Find characteristics of sensors used for light and image sensing.

Unit 01 : Operational Amplifier & Applications (06 Hrs)

Study of Various types of Operational Amplifiers and their applications; Op-Amp: Block diagrams of LM741 and TL082, ideal and practical parameters, open loop and close loop configuration, Power supply configurations, DC and AC parameters.

Applications of Op- Amp- Comparator, zero crossing detectors, Voltage limiters, Integrator and Differentiator, V-I and I-V converters, V to f and f to V circuits using LM331, peak detector.

Unit 02 : Waveform generators, Filters & Regulators (06 Hrs)

Waveform generation using Op-amp - sine, square, saw tooth and triangular generator, Active filters-Its configuration with frequency response, Analysis of first order Butterworth low pass and high pass filters, bandpass and band-stop filters, notch filter, all pass filters, Universal Active filter design using UAF42.

OP-AMP Voltage regulator, Fixed and Adjustable Voltage Regulators, Basic Switching Regulator and characteristics of standard regulator ICs –TPS40200 and Low Drop out (LDO) Regulators ICs- TPS7250.

Unit 03 : Advanced applications (06 Hrs)

Introduction to analog multiplier e.g.MPY634, Basic application of Analog multiplier: AM, FM, FSK; Typical application using op-AMP and analog multipliers: Voltage Controlled Oscillator, Phase Locked Loop and its applications, self-tuned filters.

Analog Switches and Multiplexers Overview, MUX507 Multiplexer, SN74LV4051A-Q1 8-Channel Analog Multiplexer/Demultiplexer

Unit 04 : System monitoring & protection sensing (06 Hrs)

Principle of operation and application of following sensors for Real-time system protection, feedback control and high-accuracy system monitoring: LM35 Temperature Sensor, INA240 current sense amplifier, DRV5053 Hall Effect based current sensor, HDC1080 / HDC1010 / HDC2010 Humidity Sensor.

Unit 05 : Position Sensing (06 Hrs)

Absolute and relative position sensing solutions including: angular, presence, proximity, distance, flow, level, and velocity basics, DRV 5032 Hall Effect Sensor, mmWave Sensor, AFE5805 Ultrasonic sensor, Encoder, Resolver, Inductive position sensor, Capacitive Position Sensor, LVDT.

Unit 06 : Light & image sensing (06 Hrs)

Sensors and sensing AFEs for capturing a broad range of wavelengths introduction, 3D Depth Sensor, Near Infrared spectroscopy, OPT3007 Light Sensor, Optical Isolators.

Guidelines for Instructor's Manual

Instructor's Manual shall have

- Brief relevant theory of all analog and sensing devices.
- Equipment with specifications.
- Connection diagram/ methodology.

Format of observation table, analog device characteristics and sample results.

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two reading.
6. Result table.
7. Graph and Conclusions.
8. Few short questions related to the experiment.

Guidelines for Laboratory conduction

Lab Requirement: LM741, TL082, LM331 operational amplifiers, ICs – TPS40200,TPS7250,TPS 7A4901, TPS7A8300, UAF42, MPY634, MUX507 and SN74LV4051A-Q1;LM35, INA240, DRV5053, HDC1080 modules; Angular, Presence, Proximity, Distance, Flow, level and other position sensor modules and OPT3007 light sensor module with relevant power supply and DSO/CRO and other metering equipment for characterization of all analog devices.

List of Experiments

Minimum eight experiments are to be performed out of the list mentioned as below:

1. LM741 based comparator circuit.
2. LM318 based zero crossing detector.
3. LM331 based V to f and f to V converter.
4. LM741 based triangular, square and sinusoidal waveform generation.
5. Universal Active filter design using UAF42.
6. Voltage Regulators using TPS40200 and TPS7250.
7. Analog multiplier using MPY634
8. Analog Multiplexer using MUX507
9. Study characteristics of LM35 based temperature sensor module
10. Study characteristics of HDC 1080 based Humidity sensor module
11. Hall Effect based position sensing / Ultrasonic based distance sensing.
12. Study characteristics of OPT 3007 light sensor module.

Text Books:

[T1] HANDBOOK OF OPERATIONAL AMPLIFIER APPLICATIONS, http://www.ti.com/lit/an/sboa092b/sboa092b.pdf

[T2] Thomas L. Floyd, "Electronics Devices", Pearson Education.

[T3] Mottershed, "Electronics Devices & Circuits", PHI New Delhi

[T4] Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd edition, PearsonEducation.

[T5] Linear Integrated Circuits and its Applications: https://www.ti.com/seclit/ml/ssqu016/ssqu016.pdf

[T6] http://www.ti.com/lit/ds/symlink/tps40200.pdf

[T7] www.ti.com/lit/ds/symlink/lm35.pdf

[T8] AIP Handbook of Modern Sensors: Physics, Design and Applications, Jacob Fraden, American Institute of Physics.

Reference Books:

[R1] K. R. Botkar, "Integrated Circuits", Khanna Publication, New Delhi.

[R2] James, "Operational Amplifier and Linear Integrated Circuits Theory and Application." P John Paul, "Electronics Devices and circuits", New Age international Publications.

[R3] P. S. Bimbhra, "Power Electronics", Khanna Publications

[R4] http://www.ti.com/lit/an/sboa092b/sboa092b.pdf

[R5] The Signal e-Book, Texas Instruments

[R6] http://www.ti.com/lit/ds/symlink/uaf42.pdf

[R7] https://www.ti.com/lit/ds/symlink/mpy634.pdf

[R8] www.ti.com/lit/ds/symlink/mux506.pdf

[R9] www.ti.com/lit/ds/symlink/hdc1080.pdf

[R10] The fundamentals of millimeter wave, Texas Instruments

[R11] www.ti.com/lit/ds/sbos864/sbos864.pdf

Unit	Text Books	Reference Books
1	T1, T2, T3	R1, R2, R6
2	T4, T5, T6	R3, R4, R5, R6, R7
3	-	R6, R8, R9
4	T7, T8	R6, R10
5	T8	R6, R11
6	T8	R6, R12

Elective –IV : 403150 (A): Smart Grid

Teaching Scheme		Credit	Examination Scheme [100 Marks]	
Theory	: 03 Hrs / Week	03	In Sem	: 30 Marks
			End Sem	: 70 Marks

Prerequisite: Knowledge of power system and power electronics

Course Objective: The course aims:-

- To explain the concept of Smart Grid, compare with conventional grid, and identify its opportunities and barriers.
- To describe the concept of Smart Meter, Smart Appliances, Automatic Meter Reading, Outage Management System, Plug in Hybrid Electric Vehicles, Vehicle to Grid, Smart Sensors, Home and Building Automation, Phase Shifting Transformers.
- To elaborate the concept of Substation Automation, Feeder Automation. Intelligent Electronic Devices, Smart storage like Battery, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System, Phase Measurement Unit.
- To elaborate the concept of microgrid
- To acquaint Power Quality issues of Grid connected Renewable Energy Sources, Web based Power Quality monitoring, Power Quality Audit.

Course Outcome:

1. Apply the knowledge to differentiate between Conventional and Smart Grid.
2. Identify the need of Smart Grid, Smart metering, Smart storage, Hybrid Vehicles, Home Automation, Smart Communication, and GIS
3. Comprehend the issues of micro grid
4. Solve the Power Quality problems in smart grid
5. Apply the communication technology in smart grid

Unit 01 : Introduction to Smart Grid: (06 Hrs)

Concept of Smart Grid, Need of Smart Grid, Functions of Smart Grid, Opportunities and Barriers of Smart Grid, Drivers of SG in India, Functionalities and key components of smart grid, Difference between conventional and smart grid, Smart Grid Vision and Roadmap for India, Concept of Resilient and Self-Healing Grid, Present development and International policies in Smart Grid, Smart Cities, Pilot projects in India.

Unit 02 : Smart Grid Technologies (06 Hrs)

Remote Terminal Unit (RTU):Block diagram and function of each block, Intelligent Electronic Devices (IED), Phase Measurement Unit (PMU). Smart Substations, Substation and Feeder Automation, application for monitoring, protection and control, Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid(V2G), Grid to vehicles(G2V), Smart storage technologies and applications – Battery(flow and advanced), SMES, Super Capacitors, Compressed Air Energy Storage(CAES) and its comparison, Optimal location of PMUs for complete Observability.

Unit 03 : Smart Meters and Advance Metering Infrastructure: (06 Hrs)

Introduction to Smart Meters, Advanced Metering Infrastructure (AMI), Real Time Prizing, Automatic Meter Reading (AMR), Outage Management System (OMS) Smart Sensors, Smart Appliances, Home and Building Automation, Geographic Information System (GIS).

Unit 04 : Microgrids: (06 Hrs)

Concept of Microgrid, need and applications of Microgrid, Microgrid Architecture, DC Microgrid, Formation of Microgrid, Issues of interconnection, protection and control ofMicrogrid, Integration of renewable energy sources, Smart Microgrid, Microgrid and Smart Grid Comparison, Smart Microgrid Renewable Green Energy System, Cyber Controlled Smart Grid.

Unit 05 : Power Quality Management in Smart Grid (06 Hrs)

Power Quality and EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit 06 : Communication Technology for Smart Grid (06 Hrs)

Communication Architecture of SG, Wide Area Measurement System (WAMS), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN)., ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing and Cyber Security for Smart Grid, Broadband over Power line (BPL).

Text Books:

[T1] Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley

[T2] Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”,CRC Press

[T3] Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley Publications.

[T4] Stuart Borlase, “Smart Grids-Infrastructure, Technology and Solutions”, CRC Press, Taylor and Francis group

[T5] James Momoh, “Smart Grid-Fundamentals of design and analysis”, Wiley Publications.

Reference Books:

[R1] Nikos Ziargyriour, “Micro grid, Architecture and Control”, IEEE Press, Wiley Publications.

[R2] Yang Xiao, “Communication and Networking in Smart Grids”, CRC Press, Taylor and Francis group

[R3] Lars T. Berger and Krzysztof Iniewski, “Smart Grid-Applications, Communications and Security”, Wiley Publications.

[R4] Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert “Substation Automation (Power Electronics and Power Systems)”, Springer Publications.

[R5] Smart grid handbook for regulators and policy makers November 2017,ISGF

Unit	Text Books	Reference Books
1	T1,T3,T5	R5
2	T1	R5
3	T1,T4	R4, R5
4	T1,T3	R5, R1
5	T5,T2	R5, R2
6	T4	R2, R3, R5

Elective – IV : 403150 (B): Robotics and Automation

Teaching Scheme	Credits	Examination Scheme [100Marks]	
Theory : 03 Hrs./Week	03	In Sem	: 30 Marks
		End Sem	: 70 Marks

Course Objective: The course aims to:-

- To know basic parts of a typical industrial robot system with its anatomy with human body.
- To analyze mathematically kinematic and dynamic modeling of a typical robot manipulator.
- To select an appropriate type of robot with given specifications for different industrial applications.
- To know the basics of actuators, sensors and control of an industrial robot for different applications

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Differentiate between types of robots based on configuration, method of control, types of drives, sensors used etc.
2. Choose a specific robot for specific application with given specifications.
3. Analyze the robot arm dynamics for calculation of torques and forces required for different joints of robots for control of robot arm.
4. Determine the D-H parameters for a robot configuration using concepts from robot arm kinematics which further leads to forward/inverse kinematics.
5. Calculate the Jacobian matrix for robot arm velocity and decide the singular positions.

Unit 01 : Introduction (06 Hrs)

Robot components, Degrees of freedom, Robot joints, Robot reference frames,Robot specifications: repeatability, spatial resolution, compliance, load carrying capacity, speed of response, work volume, work envelope, reach etc., end effectors (Wrist), concept of: yaw, pitch and roll. Robot classification: according to Co-ordinate system: Cartesian, cylindrical, spherical, SCARA, Articulated, Control Method: Servo controlled and non-servo controlled, their comparative study, formof motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study.

Unit 02 : Mathematical preliminaries (06 Hrs)

Homogeneous Coordinate, Translational Transformation, Rotational Transformation, coordinate reference frames, Effect of pre and post multiplication of transformation, Concept of Homogeneous transformation, Euler angles and singularities

Unit 03 : Forward Kinematics (06 Hrs)

Denavit-Hartenberg (D-H) representation of kinematic chains. Rules for establishing link co-ordinate frames. Forward solution of robotic manipulator for SCARA Robot and PUMA Robot. Forward solution for simple robot systems.

(06 Hrs)

Unit 04 :

Inverse Kinematics: Concept of Inverse Kinematics, general properties of inverse solution such as existence and uniqueness of solution, inverse solution by direct approach, Geometric approach, inverse solution for simple SCARA Robots, numericals for simple three axis robots based on direct approach.

Robot Dynamics: Lagrange's Equation, Kinetic and potential energy Equations, Euler-Lagrange analysis for a single prismatic joint working against gravity and single revolute joint. Equation of motion.

Unit 05 : Differential motion and Control **(06 Hrs)**

Manipulator Differential Motion: Concept of linear and angular velocity, Relationship between transformation matrix and angular velocity, manipulator Jacobian, Jacobian for prismatic and revolute joint, Jacobian Inverse, Singularities.

Control of Robot Arm: Modeling of DC motor and load, closed loop control in position servo, the effect of friction and gravity, control of a robotic joint, position velocity and acceleration profiles for trapezoidal velocity profile.

Control of Robot manipulator: joint position controls (JPC), resolved motion position controls (RMPC) and resolved motion rate control (RMRC).

Unit 06 : Actuators and Sensors **(06 Hrs)**

Drive Technology: Hydraulic, Pneumatic, Electric (stepper motor, D.C. servo motor, BLDC Motors) in detail with selection criteria. Sensors in servo control system: Resolver, rotary shaft encoders, potentiometers, tacho-generators.

Industrial Applications of Robots: Welding, Spray-painting, Grinding, Handling of rotary tools, Parts handling/transfer, Assembly operations, parts sorting, parts inspection, Potential applications in Nuclear and fossil fuel power plant etc. (Details for the above applications are selection criterion of robots, sensors used, selection of drives and actuators, methods of control, peripheral devices used etc).

Industrial Visit: At least one industrial visit should be arranged supporting the classroom teaching and student should submit a report on that industrial robot application including type of robot, method of control, type of application, sensor interface, method of programming etc.

Text Books:

[T1] Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Ashish Dutta, "Industrial Robotics:Technology, Programming and Applications", Tata- McGraw Hill Education Private Limited, New Delhi, 2012.

[T2] Richard D. Klafter, Thomas A. Chemielewski, Michael Neign, "Robotic Engineering – An IntegralApproach", Prentice Hall of India Pvt. Ltd., New Delhi. Eastern Economy Edition.

[T3] Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi

Reference Books:

[R1] K. S. Fu, R. C. Gonzalez, C. S. G. Lee, “Robotics: Control Sensing, Vision and Intelligence”, International Edition, McGraw Hill Book Co.

[R2] John J. Craig, “Introduction to Robotics: Mechanics and Control”, Pearson Education

[R3] R. K. Mittal, I. J. Nagrath, “Robotics and Control”, Tata McGraw Hill Publishing Company Ltd., New Delhi.

[R4] Saeed b. Niku, “Introduction to Robotics: Analysis, Control, Applications”, Wiley Publication, 2011.

Unit	Text Books	Reference Books
1	T1,T2	R3
2	T1,T2,T3	R1, R2,R3,R4
3	T1,T2,T3	R1,R3,R4
4	T1,T2,T3	R1,R3,R4
5	T2, T3	R1,R2, R3
6	T2	R1

Elective IV :403150 (C): Illumination Engineering

Teaching Scheme	Credits	Examination Scheme [100Marks]	
Theory : 03 Hr/Week	03	In Sem	: 30 Marks
		End Sem	: 70 Marks

Prerequisite:
The working of the conventional lamps, generation of light and physics of light, techniques for natural and artificial lighting

Course Objective: The course aims :-

- To explain conventional and modern lamps and their accessories.
- To get detailed insight of indoor and outdoor illumination system components, control and design aspects.
- To know the requirements of energy efficient lighting.
- To introduce the modern trends in the lighting

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. Define and reproduce various terms in illumination.
2. Identify various parameters for illumination system design.
3. Design indoor and outdoor lighting systems.
4. Enlist state of the art illumination systems.

Unit 01 : Importance of Lighting in Human Life (05 Hrs)
Optical systems of human eye, Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast, sensitivity, time illuminance, colour, visual perception, optical radiation hazards, Good and bad effects of lighting and perfect level of illumination, Artificial lighting as substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification and Measurement of light.

Unit 02 : Light Sources and Electrical Control of Light Sources (08 Hrs)
(A) Light Sources- Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low and high pressure mercury and Sodium vapour lamps, Low Vapour Pressure discharge lamps - Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL)

High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, Induction lamps.

Ballast, ignitors and dimmers for different types of lamps

(B) Control of Light Sources
Photometric Control of Light Sources and their Quantification: Types of Luminaries, factors to be considered for designing luminaries Types of lighting fixtures.

Optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, luminaries standard (IEC-598-Part I).

Unit 03 : Design Considerations for illumination schemes (04 Hrs)

Zonal cavity method for general lighting design, determination for zonal cavities and different shaped ceilings using COU (coefficient of utilization), beam angles and polar diagrams. Factors to be considered for design of indoor illumination scheme

Unit 04 : Design of lighting schemes-I (06 Hrs)

Indoor illumination design for following installations-

Residential (Numerical)
Educational institute
Commercial installation
Hospitals
Industrial lighting
Special purpose lighting schemes
Decorative lighting
Theatre lighting
Aquarium, swimming pool lighting

Unit 05 : Design of lighting schemes-II (08 Hrs)

Factors to be considered for design of outdoor illumination scheme

Outdoor Lighting Design: Road classifications according to BIS, pole arrangement, terminology, lamp and luminaries' selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method.

Outdoor illumination design for following installations:

Road lighting (Numerical)
Flood lighting (Numerical)
Stadium and sports complex
Lighting for advertisement/hoardings

Unit 06 : Modern trends in illumination (05 Hrs)

LED luminary designs
Intelligent LED fixtures
Natural light conduiting
Organic lighting system
LASERS, characteristics, features and applications, non-lighting lamps
Optical fiber, its construction as a light guide, features and applications

Text Books:

[T1] H. S. Mamak, "Book on Lighting", Publisher International lighting Academy.
[T2] Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to Lasers" Publisher -York, PA : Visions Communications
[T3] M. A. Cayless, A. M. Marsden, "Lamps and Lighting", Publisher-Butterworth-Heinemann(ISBN 978-0-415-50308-2)
[T4] Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002

Reference Books:

[R1] "BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", Manak Bhavan, New Delhi.

[R2] D. C. Pritchard, "Lighting", 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-0.

[R3] "IES Lighting Handbook", (Reference Volume 1984), Illuminating Engineering Society of North America.

[R4] "IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of North America

[R5] IESNA lighting Handbook., Illuminating Engineering Society of North America 9th edition 2000

[R6] Applied Illumination Engineering, Jack L. Lindsey FIES (Author), Scott C. Dunning PHD PECEM (Author) ,ISBN-13: 978-0824748098 ISBN-10: 0824748093, 3rd Edition.

[R7] IS 3646: Part I: 1992, Code of practice for interior illumination.

[R8] Organic Light Emitting Diodes (OLEDs): Materials, Devices and Applications, Alastair Buckley, University of Sheffieid, UK, ISBN: 978-0-85709-425-4.

Unit	Text Books	Reference Books
1	T1,T4	R6
2	T3,T4	R1,R3,R4,R8
3	T2,T4	R2,R3,R7
4	T3,T4	R2,R3,R4,R5,R7
5	T3,T2,T4	R3,R4,R6,R7
6	T1,T2,T4	R8,R5,R3,R2

403150 (D) : VLSI Design [Open Elective]

Teaching Scheme	**Credits**	**Examination Scheme [100 Marks]**
Theory : 03 Hrs. /Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisite : Concepts of Digital Electronics, Number systems, any programming language like C

Course Objective: The course aims to:-

- Develop Digital designing skills of Students
- Train the students for Hardware Description Language.
- Develop various applications using VHDL coding.

Course Outcome: Upon successful completion of this course, the students will be able to :-

1. To understand Modeling of Digital Systems Domains for different combinational and sequential circuits
2. To understand Levels of Modeling using Modeling Language VHDL.
3. To Understand Modeling and programming Concepts by Learning a New Language
4. To develop of logic design and programming skills in HDL language.
5. To study HDL based design approach.
6. To learn digital CMOS logic design

Unit 01 : Overview of Digital Logic Circuits and Introduction to VLSI (06 Hrs)

Combinational circuits: Decoders, Multiplexer, ALU. Sequential circuits: latch, flip flop – RS, JK, D,T., shift registers ,Counters, Moore, Mealy Machines. Introduction to VLSI: complete VLSI design flow (with reference to an EDA tool), IEEE Standards ,VHDL Terms Definitions – Entity, architecture, Schematic, Components, Configuration.

Unit 02 : VHDL Modeling (06 Hrs)

Data objects, Data types, Entity, Architecture and types of modeling: Behavioral, data flow, and Structural with the help of digital functions like multiplexer, Shift Register, counter. Sequential statements, Concurrent statements. VHDL Test bench. VHDL modeling of Combinational, Sequential logics.

Unit 03 : VHDL and Finite State Machines (06 Hrs)

Synthesizable and non synthesizable statements, functions, procedures, attributes, configurations, packages. Synchronous and asynchronous machines, Finite State Machines (FSM), metastability, state diagrams and VHDL codes for FSMs.

Unit 04 : Programmable Logic Devices (PLDs) (06 Hrs)

Need of PLDs. Comparison with ASIC, general purpose processor, DSP processor, microcontroller, memories etc. Features, specifications, detail architectures, application areas, limitations of Complex Programmable Logic Device (CPLD) and Field Programmable Logic Devices (FPGA).

Unit 05 : Digital CMOS Design (06 Hrs)

CMOS INVERTER, CMOS NAND and CMOS NOR, voltage transfer curve, body effect, hot electron effect, velocity saturation. Static and dynamic dissipations. Power delay product. Noise margin. Combinational logic design, comparison of CMOS and NMOS. Comparative study of TTL, ECL, CMOS.

Unit 06 : VLSI Design Applications (06 Hrs)

Barrel shifter, signed and unsigned comparators, Carry ripple and carry look, Ahead address, Fixed- point division, serial data receiver, parallel to serial converter, playing with a seven segment display and key board, signal generators, memory design, Vending - Machine controller.

Text Books:

[T1] Douglas Perry, "VHDL", Tata McGraw Hill.

[T2] John F. Wakerly, "Digital Design, Principles and Practices", Prentice Hall Publication

[T3] Wolf, "Modern VLSI Design", Pearson Education.

[T4] R.P.Jain, "Modern Digital electronics", 3rd edition, Tata McGraw-Hill.

[T5] Donald P. Leach, Albert Paul Malvino, "Digital Principles and Applications", Glencoe Publisher.

[T6] Neil H. Weste and Kamran, "Principles of CMOS VLSI Design", Pearson Publication.

Reference Books:

[R1] Charles H. Roth, "Digital System Design Using VHDL", PWS Publishing Company (Thomson Learning) 2.

[R2] Sung-Mo(Steve) Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits", Tata McGraw Hill Publication.

[R3] J. Bhaskar, "VHDL Primer", 3rd Edition, Addison Wesley Longman Singapore Pte Ltd.

[R4] Volner A. Dedroni, "Circuit Design with VHDL", PHI Publications

[R5] Xilinx Data Manual "The Programmable Logic Data Book".

[R6] LizyKurian John, "Principles of Digital Systems Design and VHDL" Paperback – 2008 .

[R7] Peter J. Ashenden (Author), Jim Lewis, " VHDL-2008: Just the New Stuff", (Systems on Silicon) Paperback – Import, 7 Dec 2007.

[R8] Data Sheets of PLDs.

Unit	Text Books	Reference Books
1	T2,T4,T5	R3, R6
2	T1,T3	R3, R4, R7
3	T2,T1	R1, R6
4	T2	R5, R8
5	T6	R2
6	T2,T3	R6

403151: Project II

Teaching Scheme	Credits	Examination Scheme [150 Marks]
Tutorial : 06 Hrs./Week	06	Oral : 50 Marks Term work : 100 Marks

Course Objectives:

- To explore and to acquire specified skill in areas related to Electrical Engineering
- To develop skills for carrying literature survey and organize the material in proper manner.
- To provide opportunity of designing and building complete system/subsystem based on their knowledge acquired during graduation.
- To understand the needs of society and based on it to contribute towards its betterment and to learn to work in a team.
- To ensure the completion of given project such as fabrication, conducting experimentation, analysis, validation with optimized cost.
- Present the data and results in report form
- Communicate findings of the completed work systematically.

Course outcomes: Students will be able to

- Work in team and ensure satisfactory completion of project in all respect.
- Handle different tools to complete the given task and to acquire specified knowledge in area of interest.
- Provide solution to the current issues faced by the society.
- Practice moral and ethical value while completing the given task.
- Communicate effectively findings in verbal and written forms.

Guidelines :

The student shall complete the remaining part of the project which is an extension of the work carried out in VIIth Semester. For exceptional cases, change of topic has to be approved by Internal Assessment Committee consisting of Guide, Project Coordinator and Head of Department.
Student should incorporate suggestions given by examiner in project I.
The student shall complete the remaining part of the project which consists of design, simulation, fabrication of set up required for the project, analysis and validation of results and conclusions.
The student shall prepare duly certified final report of the project work in the standard format in MS Word / LaTex.
Student should maintain Project Work Book.

Audit Course VI : 403153: Energy Storage Systems

Teaching Scheme
Theory : 02 Hrs. / Week
Field visit : 1 Day

Examination Schemes: Audit (P/F)
Written / MCQ / Term paper

Course Objectives:

- To elaborate various energy storage systems
- To be familiar with various aspects such as hybridization, selection and sizing of energy storage systems

Course Outcomes:

On completion of the course, students will be able to:-

- Explain and differentiate various types of energy storage systems

Energy Storage Systems:

1. Introduction to Energy Storage System: need, its types and applications.

a) Battery as an energy storage device, its types, Basic terms related to battery Energy Storage System such as Energy Density, Power Density, Cycle Life, C_{10} Rating, State of Charge (SOC), Depth of Discharge (DOD), its characteristics and analysis of various batteries.

b) Types of Batteries: Characteristics, construction, economics, development status, future trends in batteries such as advanced lead-acid, lithium ion, polymer, Ni-Cd, metal hydride, sodium, and various types of flow batteries (vanadium, zinc, manganese, etc.).

c) Fuel Cell as an energy storage device and its analysis.

d) Supercapacitor as an energy storage device and its analysis.

e) Superconducting Energy Storage as an energy storage device and its analysis.

f) Flywheel as an energy storage device and its analysis.

Hybridization of different energy storage devices.

Sizing and selecting the energy storage technology and its supporting subsystems.

2. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV) Introduction to energy management strategies used in hybrid and electric vehicles.

Experiments: There shall be a 3-4 exercises based on MATLAB and Simulink related to **Battery** energy storage, **Fuel Cell** energy storage and **Supercapacitor** energy storage.

Industrial Visit: Industrial visit to manufacturing industry of battery/ supercapacitor.

Savitribai Phule University of Pune, Pune
Final Year E&TC Engineering (2015 Course)
(With effect from Academic Year 2018-19)

Semester I

Course Code	Course	Teaching Scheme Hours / Week			Semester Examination Scheme of Marks						Credits	
		Theory	Tutorials	Practicals	In-Sem	End-Sem	TW	PR	OR	Total	TH/TW	PR+OR
404181	VLSI Design & Technology	3	--	--	30	70	--	--	--	100	3	--
404182	Computer Networks & Security	4	--	--	30	70	--	--	--	100	4	--
404183	Radiation & Microwave Techniques	3	--	--	30	70	--	--	--	100	3	--
404184	Elective I	3	--	--	30	70	--	--	--	100	3	--
404185	Elective II	3			30	70	--	--	--	100	3	--
404186	Lab practice -I (CNS+ RMT)	--	--	4	--	--	50	--	50	100	--	2
404187	Lab practice -II (VLSI + Ele I)	--	--	4	--	--	50	50		100	--	2
404188	Project Stage I	-	2	--	--	--	-	--	50	50	--	2
	Audit Course 5	--	--	--	--	--	--	--	--	--	----	
Total		16	2	8	150	350	100	100	50	750	6	
Total Credits											**22**	

Elective I	**Elective II**
Digital Image and Video Processing	Wavelets
Industrial Drives and Control	
Embedded Systems & RTOS	Optimization Techniques
Internet of Things	Artificial Intelligence
	Electronics in agriculture
	Audit Course 5:
	Green Energy
	Human Behavior

Final Year E&TC Engineering (2015 Course)

(With effect from Academic Year 2018-19)

Semester II

Course Code	Course	Teaching Scheme Hours / Week			Semester Examination Scheme of Marks							Credit	
		Theory	Tutorials	Practicals	In-Sem	End-Sem	TW	PR	OR	Total	TH/TW	PR+OR
404189	Mobile Communication	3	--	--	30	70	--	--	--	100	3	--
404190	Broadband Communication Systems	4	--	--	30	70	--	--	--	100	4	--
404191	Elective III	3	--	--	30	70	--	--	--	100	3	--
404192	Elective IV	3	--	--	30	70	--	--	--	100	3	--
404193	Lab practice -III	--	--	4	--	--	50	50	--	100	--	2
404194	Lab practice -IV (Ele III)	--	--	2	--	--	--	--	50	50	--	1
404195	Project Stage II	--	6	-	--	--	150	--	50	200	--	6
	Audit Course 6	--	--	--	--	--	--	--	--	--		
	Total	13	6	6	120	280	200	50	100	750	13	9
										Total Credits	22	

Elective III	Elective-IV
Machine Learning	Robotics
PLC s and Automation	Bio-Medical Electronics
Audio and Speech Processing	Wireless Sensor Networks
Software Defined Radio	Renewable Energy Systems
Audio Video Engineering	Open Elective*
	Audit Course 6:
	Team Building, Leadership and Fitness for Engineers
	Environment and Disater Management

*Any one subject from the list of Elective IV of computer/IT/Electrical/Instrumentation or Institute can offer elective IV based on any industry need with prior approval from BoS(Electronics). Repetition of subjects or topics is to be avoided.

404181 VLSI Design & Technology

Credits: 03

Teaching Scheme:	**Examination Scheme:**
Lecture : 03 hr/week	**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- ✓ To explore HDL and related design approach.
- ✓ To nurture students with CMOS circuit designs.
- ✓ To realize importance of testability in logic circuit design.
- ✓ To overview ASIC issues and understand PLD architectures with advanced features.

Course Outcomes:

On completion of the course, student will be able to

1. Write effective HDL coding for digital design.
2. Apply knowledge of real time issues in digital design.
3. Model digital circuit with HDL, simulate, synthesis and prototype in PLDs.
4. Design CMOS circuits for specified applications.
5. Analyze various issues and constraints in design of an ASIC
6. Apply knowledge of testability in design and build self test circuit.

Course Contents

Unit I : HDL Design **(7 Hrs)**

Design Flow, Language constructs, Data objects, Data types, Entity, Architecture & types of modeling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, HDL modeling of Combinational, Sequential circuits and FSM. Simulations, Synthesis, Efficient coding styles, Hierarchical and flat designs, Partitioning for synthesis, Pipelining, Resource sharing.

Unit II : Digital design and Issues **(6 Hrs)**

Sequential synchronous machine design, Moore and Mealy machines, HDL code for Machines, FIFO. Metastability and solutions, Noise margin, Fan-out, Skew, Timing considerations, Hazards, Clock distribution, Clock jitter, Supply and ground bounce, Power distribution techniques, Power optimization, Interconnect routing techniques; Wire parasitic, Signal integrity issues. I/O architecture.

Unit III : PLD Architectures and applications **(6 Hrs)**

Design Flow. CPLD Architecture, Features, Specifications, Applications. FPGA Architecture, Features, Specifications, Applications. The Simulation and Synthesis Tools, FPGA synthesis and implementation.

Unit IV: Digital CMOS circuits **(7 Hrs)**

N-MOS, P-MOS and CMOS, MOSFET parasitic, Technology scaling, Channel length modulation, Hot electron effect, Velocity saturation, CMOS Inverter, Device sizing, CMOS combinational logic design, Power dissipations, Power delay product, Body Effect, Rise and fall times, Latch Up effect, transmission gates.

Unit V : Application Specific Integrated Circuit **(7 Hrs)**

Design Flow, Cell design specifications, Spice simulation, AC and DC analysis, Transfer Characteristics, Transient responses, Noise analysis, Lambda rules, Design rule check, Fabrication methods of circuit elements, Layout of cell, Library cell designing for NAND & NOR, Circuit Extraction, Electrical rule check, Layout Vs. Schematic, Post-layout Simulation and Parasitic extraction, Design Issues like Antenna effect, Electro migration effect, Cross talk and Drain punch through, Timing analysis.

Unit VI : VLSI Testing and Analysis **(6 Hrs)**

Types of fault, Need of Design for Testability (DFT), DFT Guideline, Testability, Fault models, Path sensitizing, Test pattern generation, Sequential circuit test, Built-in Self Test, JTAG & Boundary scan, TAP Controller.

Text Books:

1. Charles H. Roth, "Digital systems design using VHDL", PWS.
2. Wyane Wolf, "Modern VLSI Design (IP-Based Design)", 4E,Prentice Hall.
3. Steve Kilts "Advanced FPGA Design Architecture, Implementation and Optimization", Wiley.

Reference Books:

1. E. Weste, David Money Harris, "CMOS VLSI Design: A Circuit & System Perspective", Pearson Publication.
2. R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", 3E, Wiley-IEEE Press
3. John F. Wakerly, "Digital Design Principles and Practices" , 3E, Prentice Hall
4. M. Morris Mano , "Digital Design", 3E , Pearson
5. Cem Unsalan, Bora Tar, "Digital System Design with FPGA: Implementation Using Verilog and VHDL", McGraw-Hill

404182 Computer Networks & Security				
Credits: 04				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 04 Hrs/week				**In-Sem: 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- To understand state-of-the-art in network protocols, architectures, and applications
- To provide students with a theoretical and practical base in computer networks issues
- To outline the basic network configurations
- To understand the transmission methods underlying LAN and WAN technologies.
- To understand security issues involved in LAN and Internet.

Course Outcomes:

On completion of the course, student will be able to

- Understand fundamental underlying principles of computer networking
- Describe and analyze the hardware, software, components of a network and their interrelations.
- Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies
- Have a basic knowledge of installing and configuring networking applications.
- Specify and identify deficiencies in existing protocols, and then go onto select new and better protocols.
- Have a basic knowledge of the use of cryptography and network security.

Course Contents

Unit I : Introduction to Local Area Networks **(6Hrs)**

TCP/IP Protocol Suit, Media Access Control: Random Access, Controlled Access- Reservation, Channelization

Wired LAN: Ethernet Protocol, Standard Ethernet, Fast Ethernet (100 MBPS), Gigabit Ethernet, 10 Gigabit Ethernet

Wireless LAN : Introduction, IEEE 802.11 Project, Bluetooth

Unit II :Network Layer Part I **(7Hrs)**

Introduction to Network Layer: Network-Layer Services, Packet Switching, Network-Layer Performance, IPv4 Addresses, Forwarding Of IP Packets,

Network Layer Protocols: Internet Protocol (IP), ICMPv4, Mobile IP

Unit III : Network Layer Part II **(6 Hrs)**

Unicast and Multicast Routing: Introduction, Routing Algorithms, Unicast Routing Protocols,

Introduction, Multicasting Basics, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, IGMP

Next Generation IP:IPv6 Addressing, The Ipv6 Protocol, TheICMPv6 Protocol, Transition From IPv4 toIPv6.

Unit IV : Transport Layer **(6 Hrs)**

Introduction to Transport Layer: Introduction, Transport-Layer Protocols,

Transport Layer Protocols: Introduction, User Datagram Protocol, Transmission Control Protocol, SCTP.

Unit V : Application Layer (7 Hrs)

Introduction to Application Layer, Standard Client Server Protocols: World Wide Web and HTTP , FTP, Electronic Mail, Telenet, SSH, DNS.

Network Management: Introduction, SNMP.

Unit VI : Network Security **(7Hrs)**

Cryptography & Network Security: Introduction Confidentiality, Other Aspects Of Security.

Internet Security: Network-Layer Security, Transport-Layer Security, Application-Layer Security, Firewalls.

Text Books:

1. Behrouz A. Forouzan, "Data Communications and Networking" MacGraw Hill, 5th edition
2. James F. Kurouse& W. Rouse, "Computer Networking: A Top down Approach", 6thEdition, Pearson Education.

Reference Books:

1. Andrew S. Tannenbaum, "Computer Networks", Pearson Education, Fourth Edition,2003
2. Wayne Tomasi, "Introduction to Data Communication and Networking", 1/e, Pearson Education
3. Natalia Olifer, Victor Olifer, "Computer Networks" Wiley Student Edition

404183 Radiation and Microwave Techniques

Credits: 03

Teaching Scheme:			Examination Scheme:	
Lecture : 03 hr/week				In-Sem : 30 Marks End-Sem : 70 Marks

Course Objectives:

- To introduce fundamental theory of radiation and microwaves.
- To understand design principles of various radiating elements.
- To understand theory of passive and active components of microwave systems.
- To learn microwave measurement techniques.

Course Outcomes:

On completion of the course, student will be able to

1. Differentiate various performance parameters of radiating elements.
2. Analyze various radiating elements and arrays.
3. Apply the knowledge of waveguide fundamentals in design of transmission lines.
4. Design and set up a system consisting of various passive microwave components.
5. Analyze tube based and solid state active devices along with their applications.
6. Measure various performance parameters of microwave components.

Course Contents

Unit I : Fundamental Theory of Radiation and Radiating Elements (8Hrs)

Fundamental equations for free space propagation, Friis transmission equation, Definition of antenna, radiation mechanism and types of antenna, performance parameters such as radiation pattern, directivity, gain, efficiency, half power beam width, bandwidth, polarization, input impedance, radiation efficiency, effective length, effective area, radiation sphere.

Unit II : Radiating elements and arrays (7Hrs)

Comparison of various radiating elements such as infinitesimal dipole, small dipole, finite length dipole and half wave length dipole, analytical treatment of these elements. Planar, log periodic and Yagi Uda antenna. Types of arrays, two element array, N-element array, uniform amplitude uniformly spaced linear broad side and end-fire array.

Unit III : Transmission lines and Waveguides (6Hrs)

General solution for TEM, TE and TM waves. Analysis of coaxial line and rectangular waveguides. Analysis of rectangular cavity resonators and their applications, Striplines: Structural details, types and applications.

Unit IV : Passive Microwave Components (6Hrs)

Construction, working principle and scattering analysis of passive microwave components such as E-plane, H-plane and magic tee. Ferrite composition, characteristics and Faraday rotation principle. Construction, working principle and scattering analysis of isolator, circulator and directional coupler. Construction and operation of gyrator.

Unit V: Active Microwave Components **(6Hrs)** Limitations of conventional tubes, O and M type classification of microwave tubes, re-entrant cavity, velocity modulation. Construction, operation, performance analysis and applications of - Single cavity and two cavity klystron, Cylindrical wave magnetron and Helix traveling wave. Construction, working principle and applications of two terminal microwave devices such as tunnel diode, Gunn Diode, PIN Diode, Schottky Barrier Diode and Varactor.
Unit VI : Microwave Systems and Microwave Measurement Techniques **(6Hrs)** Microwave terrestrial and satellite communication system and industrial applications of microwaves such as microwave heating, thickness and moisture measurement, medical application such as microwave diathermy. Microwave measurement devices such as slotted line, tunable detector, VSWR meter, power meter, and their working principles. Microwave measurement techniques to measure S-parameters, frequency, power, attenuation, phase shift, VSWR, impedance. Radiation hazards and protection.
Text Books: 1. C.A. Balanis, “Antenna Theory - Analysis and Design", John Wiley. 2. Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd edition, Pearson 3. Annapurna Das and Sisir K. Das, “Microwave Engineering", Second edition, Tata Mc Graw Hill.
Reference Books: 1. David M. Pozar, “Microwave Engineering", Fourth edition, Wiley. 2. Ahmad Shahid Khan, “Microwave Engineering : Concepts and Fundamentals 3. K. D. Prasad, “Antenna &Wave Propagation”, Satya Prakashan, New Delhi. 4. M. Kulkarni, “Microwave and Radar engineering”, 3rd edition, Umesh Publication 5. E.C. Jordon and E.G. Balman, “Electromagnetic Waves and Radiation Systems”, Prentice Hall India.

404184 Digital Image and Video Processing (Elective-I)				
Credits: 03				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

1. Understand the fundamental concepts of Digital Image Processing with basic relationship of pixels and mathematical operations on 2-D data.
2. Learn design and integrate image enhancement and image restoration techniques
3. Understand object segmentation and image analysis techniques
4. Learn the need for effective use of resources such as storage and bandwidth and ways to provide effective use of them by data compression techniques
5. Learn basic concepts of video processing

Course Outcomes:

On completion of the course, student will be able to

1) Develop and implement basic mathematical operations on digital images.
2) Analyze and solve image enhancement and image restoration problems.
3) Identify and design image processing techniques for object segmentation and recognition.
4) Represent objects and region of the image with appropriate method.
5) Apply 2-D data compression techniques for digital images.
6) Explore video signal representation and different algorithm for video processing.

Course Contents

Unit I : Fundamentals of Image Processing **(5 Hrs)**

Steps in Image processing, Human visual system, Sampling & quantization, Representing digital images, spatial and gray level resolution, Image file formats, Basic relationships between pixels, Distance Measures, Basic operations on images – image addition, subtraction, logical operations, scaling translation, rotation. Color fundamentals and models – RGB, HIS, YIQ

Unit II : Image Enhancement and Restoration **(8 Hrs)**

Point – Log transformation, Power law transformation, Piecewise linear transformation, Image histogram, histogram equalization, Mask processing of images, filtering operations- Image smoothing, image sharpening, frequency domains image enhancement: 2D DFT, smoothing and sharpening in frequency domein, Pseudo coloring.

Image Restoration: Noise models, restoration using Inverse filtering and Wiener filtering

Unit III : Image Compression **(6 Hrs)**

Types of redundancy, Fidelity criteria, Compression models - Information theoretic perspective – Fundamental coding theorem, Lossless Compression: Huffman Coding- Arithmetic coding. Introduction to DCT, Lossy compression: DCT based compression, Wavelet based compression, Image compression standards JPEG and JPEG 2000.

Unit III : Image Segmentation (8 Hrs)

Pixel classification, Bi-level thresholding, Multi-level thresholding, Adaptive thresholding, Otsu's method, Edge detection – First order derivative Prewitt and Sobel, Second order derivative – LoG, DoG, Canny. Edge linking, Hough transform, Region growing and region merging. Morphological operators: Dilation, Erosion, Opening, Closing, Hit or Miss transform, Boundary detection, Thinning, Thicking, Skelton

Unit V : Representation and Description **(5 Hrs)**

Representation – Chain codes, Polygonal approximation, Signatures, Boundary descriptors, Shape numbers, Fourier descriptors, Stastical moments, Regional descriptors – Topological, texture, Principal components for description

Unit VI :	**(6 Hrs)**
Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Motion Estimation; Video Filtering; Video Compression, Video coding standards MPEG.	
Text Books: 1. Gonzalez and Woods, "Digital Image Processing", Pearson Education, 3rd edition 2. Iain E. G. Richardson, "H.264 and MPEG 4 Video Compression: Video Coding for Next Generation Multimedia", John Wiley and Son's Publication, 3rd Edition.	
Reference Books: 1. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989. 2. Pratt William K. "Digital Image Processing", John Wiley & sons 3. A. Bovik, Handbook of Image & Video Processing, Academic Press, 2000	

404184 Industrial Drives and Control (Elective-I)

Credits: 03

Teaching Scheme:				**Examination Scheme:**
Lecture : 3Hours / Week **Practical: 2Hours /Week**				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- Describe the structure of Electric Drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology
- Study and understand the operation of electric motor drives controlled from a power electronic converter and to introduce the design concepts of controllers for closed loop operation
- Study DC, AC, special machines like stepper motor, servo motor and brushless motor and their control.

Course Outcomes:

On completion of the course, student will be able to

1. Understand the basic principles of power electronics in drives and its control, types of drives and basic requirements placed by mechanical systems on electric drives for various applications
2. Understand the operation of 1ϕ & 3ϕ converter drives for separately excited & series DC motors, dual converter drives, 2 quadrant and 4 quadrant DC chopper drives, Open-loop & closed-loop control of DC drives with transfer function, Dynamic and regenerative braking. Protection circuits for DC drives.
3. Learn speed control of induction motor drives in an energy efficient manner using power electronics. To study and understand the operation of both classical and modern induction motor drives like FOC or Vector control.
4. Learn and understand working of various types of synchronous motors and their drive systems
5. Learn stepper motors & drives, BLDC and SRM motors and drives
6. Understand modern control techniques of Fuzzy logic and ANN in motor drive application

Course Contents

Unit I :Motor Drive as system (5 Hrs)

Electrical drive as system, Parts of Electrical drives AC / DC drives, Components, nature and classification of load torques. Four quadrant operation of a motor drive. Control of Electrical drives, steady state stability Closed loop control, Selection of motor power rating

Unit II : DC Motors and drives(6Hrs)

Basic characteristics of DC motors, Operating modes, Motor performance parameters, 1ϕ & 3ϕ converter drives for separately excited & series DC motors for continuous & discontinuous operations. Chopper fed DC drives, Comparison of converter fed drive & chopper fed drive. Open loop & closed loop control of dc drives with transfer function PLL control, Microprocessor based control of dc drives, Dynamic and regenerative braking of DC motors

Unit III :Induction Motors and Drives(8Hrs)

Induction motor characteristics, Control strategies like stator voltage control, v/f control, rotor resistance control, Variable frequency Square wave VSI Drives, Variable frequency PWM VSI Drives, Variable frequency CSI Drives, Closed loop control of Induction motors, v/f control of three phase IM using PWM inverter, Vector Control (Field oriented Control): Basic principle of vector control, Direct vector control & indirect vector control, DQ Transformation, Braking of induction motor, soft acceleration and deceleration, various protections.

Unit IV :AC and DC synchronous Motors and drives(6Hrs)

Cylindrical rotor motor Drive, Salient pole motor Drive, Switched reluctance motor (SRM) drive, Synchronous Reluctance motor drive, self-controlled synchronous motor drives Permanent magnet Brushless DC motor drive, Permanent magnet AC synchronous motor drive, Variable reluctance & permanent magnet stepper motor and drive. Servo motor Drives.

Unit V :Power Electronics applications inRenewable Energy (6Hrs)

Wind power system: System component, Turbine rating, Electrical load matching, fixed speed and variable speed operation, System design features, Maximum power operations and System control requirement WECS: Principle of WECS, role of power electronics in WECS, Drive selection criteria for fixed speed and variable speed WECS, Stand-alone PV systems, Grid connected PV systems. Power Electronics for Photovoltaic Power Systems Basics of Photovoltaic: The PV cell, Module and array, I-V and P-V curves, PV system component, Stand-alone PV systems, Grid connected PV systems.

Unit VI :Artificial Intelligence in Motor Drives(5Hrs)

Fuzzy logic principle and applications: Introduction, Fuzzy sets, Fuzzy system, Fuzzy control, Fuzzy logic based induction motor speed control.

Neural network principle and applications: Introduction, Neural network in identification and control, AI Applications in electrical machines and drives, Neural network based PWM controller

Text Books:

1. Fundamental of Electrical Drives, Gopal K. Dubey, Narosa Publishing House .
2. Power Electronics, circuits, devises and applications by Muhammad Rashid, Pearson
3. Modern Power Electronics and AC Drives, Bimal K. Bose, Pearson

Reference Books:

1. Wind & Solar Power system, Mukund Patel , CRC Press
2. Thyristor DC drives, P. C Sen, John Wiley.
3. Power Electronics, Converters, Applications and Design, N. Mohan, T. M. Undeland &W. P. Robbins, John Wiley and Sons, 3rd Edition

404184 Embedded systems and RTOS (Elective-I)

Credits: 03

Teaching Scheme:		**Examination Scheme:**
Lecture : 03hr/week		**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- To understand and able to design an application specific systems.
- To develop implementation skill for application specific systems.
- To understand design and implementation of real time system using RTOS.
- To understand open source platform for embedded system

Course Outcomes:

On completion of the course, student will be able to

1) understand design of embedded system
2) use RTOS in embedded application
3) use modern architecture for embedded system
4) use Linux for embedded system development
5) use open platform for embedded system development

Course Contents

Unit I : Embedded System Overview

Embedded System Introduction, Hardware and software architectures of ES, Design metrics(technical and techno- economical), Prototyping models, Development tool chain insights(GNU), guidelines for Selection of hardware and memory architecture, embedded C programming, embedded system design challenges, standard programming practices in embedded system. **(06 Hrs)**

Unit II :Real time system and RTOS

Real time system, types, design approaches and considerations, Usage ofShared resourcesand related issues, Concept of RTOS, Types of RTOS, differences from GPOS (Multitasking, interprocess communication, Timers, Device drivers, protection mechanism etc), real time scheduling algorithms, commercial RTOS , survey of RTOS **(7Hrs)**

Unit III :µcos-II –RTOS

µcos-II features, kernel structure, data structure, µcos-II services as task management, time management, interprocess communication (mailbox, queue,events,pipes etc), memory management.µcos-II porting on ARM7/Cortex (M3/M4) architecture. **(8Hrs)**

Unit IV : Advanced embedded architectures (Cortex-M3/M4)

Introduction to ARM CORTEX series, Design Philosophy, processors series, versions, features and applications. CMSIS standard for ARM Cortex. Survey of CORTEX M3/M4 based controllers. ARM-CM3 Based Microcontroller LPC1768: Features, Architecture (Block Diagram & Its Description), System Control, Clock & Power Control, GPIO, Pin Connect Block, interfacing with RGB LED, Seven Segment, TFT Display, MOTOR control using PWM **(8Hrs)**

Unit V : Embedded Linux

Linux for embedded systems, embedded Linux development system, kernel architecture and configuration, file systems, porting Linux on ARM architecture, bootloaders, tool utilities such as Minicomp, Busybox, Redboot, Libc, Device drivers- concept, architecture, types, sample character device driver, **(8Hrs)**

Unit VI :Open hardware /development systems and Case study

Arduino open platform (IDE), development using ATMega328p based Uno board, structure of Arduino programs, introduction to Arduino library, sample GPIO program.

Case study of implementation with control, compute and communication modules using Arduino platform.

(7Hrs)

Text Books:

1. Jean J.Labrosse, "MicroC OS II, The Real-Time Kernel", 2nd edition, CMP Books.
2. Christopher Hallinan, "Embedded Linux Primer -A Practical, Real-World Approach "2nd edition, Prentice Hall.
3. Parag H Dave, Himanshu .H.Dave," Embedded systems" Concepts, design and programming, Pearson India

Reference Books:

1. Frank Vahid and Tony Givargis, " Embedded System Design – A Unified hardware/ Software introduction " 3rd edition, Wiley
2. David Simon, "Embedded system primer"
3. Raj Kamal, "Embedded Systems – Architecture, Programming and Design" 2nd edition,

http://www.ti.com/lit/an/slaa207/slaa207.pdf

MSP430x5xx: http://www.ti.com/product/msp430f5529
MSP430x4xx : http://www.ti.com/product/msp430f438
MSP430x2xx: http://www.ti.com/product/msp430g2302-ep

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404184	**Internet of Things (Elective-I)**			
Credits: 03				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- To study fundamental concepts of IoT
- To understand roles of sensors in IoT
- To Learn different protocols used for IoT design
- To be familiar with data handling and analytics tools in IoT

Course Outcomes:

On completion of the course, student will be able to

1)Understand the various concepts, terminologies and architecture of IoT systems.

2) Use sensors and actuators for design of IoT.

3) Understand and apply various protocols for design of IoT systems

4) Use various techniques of data storage and analytics in IoT

5) Understand various applications of IoT

Course Contents

Unit I : Fundamentals of IoT	**(6 Hrs)**
Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.	
Unit II :Sensors Networks	**(7Hrs)**
Definition, Types of Sensors, Types of Actuators, Examples and Working, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.	
Unit III :Wireless Technologies for IoT	**(6 Hrs)**
WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus.	
Unit IV :IP Based Protocols for IoT	**(6 Hrs)**
IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT.	
Unit V :Data Handling& Analytics	**(6Hrs)**
Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop Introduction to data Analytics, Types of Data analytics, Statistical Models, Analysis of Variance, Data Dispersion, Contingence and Correlation, Regression Analysis, Precision and Error limits.	
Unit VI :Applications of IoT	**(7Hrs)**
Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, IoT design Ethics, IoT in Environmental Protection.	
Text Books: 1.Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Wiley Publications 2. Olivier Hersent, David Boswarthick, and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", WileyPublications 3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.	
References 1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications 2. by Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press 3. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html 4. https://onlinecourses.nptel.ac.in/noc17_cs22/course	

404185	Wavelets (Elective-II)			
Credits: 03				
Teaching Scheme:			Examination Scheme:	
Lecture : 03 hr/week				In-Sem : 30 Marks End-Sem: 70 Marks

Course Objectives:

1. Learn and understand basic linear algebra
2. Understand the need of time frequency resolution
3. Understand the basics of Discrete Wavelet transform and various wavelets available
4. Learn the signal analysis using multi-resolution analysis
5. Study the applications of Wavelets in compression, enhancement, noise removal etc.

Course Outcomes:

On completion of the course, student will be able to

1) Explore and learn the basics of linear algebra.

2) Identify the need of Wavelet transform and its properties.

3) Analyze the 1-D and 2-D signal using discrete wavelet transform.

4) Analyze the signal using Multi resolution analysis

5) Use wavelet transform in different applications like data compression, denoising, enhancement etc

Course Contents

Unit I : Fundamentals of Linear Algebra (6 Hrs)

Vector spaces, Orthogonality, Ortho-normality, Projection, Functions and function spaces. Orthogonal basis functions. Fourier series orthogonality of complex exponential bases, mathematical preliminaries for continuous and discrete Fourier transformer. Limitations of Fourier domain signal processing, Towards wavelet signal processing, signal representation with continuous and discrete Short Time Fourier Transform.

Unit II : Introduction to Wavelet **(6 Hrs)** Concept of time-frequency resolution, Resolution problem associated with STFT, Heisenberg's uncertainty principle and time frequency tiling, why wavelet transform? The origin of wavelets, Properties of Wavelet Transform, Wavelet and other wavelet like transformer, different communities and family of wavelets, different families of wavelets within wavelet communities, Continuous and discrete wavelet transform
Unit III : Discrete Wavelet Transform **(8 Hrs)** Haar scaling function and function spaces, translation and scaling of φ(t), function spaces V0 Finer Haar Scaling Functions, concept of nested vectopr spaces, Haar wavelet function, scaled and translated Haar wavelet functions, orthogonality of φ (t) and γ (t). Normalization of Haar bases at different scales, daubechies wavelets, plotting of Daubechies wavelets. 1-D and 2-D decomposition (analysis) of signals using Wavelet.
Unit IV : Multi-resolution Analysis **(6 Hrs)** Signal decomposition and its relation with filter banks, frequencies response, signal reconstruction course to fine scale, upsampling and filtering, QMF conditions, concepts of multi-Resolution analysis and multi-rate signal processing, Perfect matching filters, Vanishing moments of wavelet function and filter properties, introduction to wavelet lifting
Unit V : Wavelet Transform in Data Compression **(6 Hrs)** Transform coding, image compression using DWT, Embedded tree image coding, comparison of JPEG and JPEG 2000, Audio masking, MPEG Coding for audio, Wavelet based audio coding, video coding using Multi-resolution technique (introduction).
Unit VI : Applications of Wavelet Transform **(4 Hrs)** wavelet denoising, speckle removal, Edge detection and object isolation Image fusion, wavelet watermark, image enhancement. Communication application scaling functions as signaling pulses, Discrete Wavelet Multitone modulation.
Text Books: 1. K.P Soman, K I Ramchandran, N G Resmi, "Insights into Wavelets from theory to Practice", Third edition, PHI publication. 2. 2. Raghuveer M Rao, Ajit S. Bopardikar, "Wavelet Transforms, Introduction to Theory and Applications", Seventh Indian Reprint 2005, Pearson Education.

Reference Books:

1. Jaideva C. Goswami, Andrew K. Chan, “Fundamentals of Wavelets”, Wiley Student Edition
2. V. M. Gadre, A. S. Abhyankar, “Multiresolution and Multirate Signal Processing, Introduction, Principles and Applications”, MGH Publication

404185 Electronic Product Design

Teaching Scheme:		**Examination Scheme:**
Lectures: 3 Hrs./ Week		In Semester Assessment: Phase I : 30 End Semester Examination: Phase II: 70

Course Objectives:

- To understand the stages of product (hardware/ software) design and development.
- To learn the different considerations of analog, digital and mixed circuit design.
- To be acquainted with methods of PCB design and different tools used for PCB Design.
- To understand the importance of testing in product design cycle. `
- To understand the processes and importance of documentation.

Course Outcomes:

After successfully completing the course students will be able to

- Understand various stages of hardware, software and PCB design.
- Importance of product test & test specifications.
- Special design considerations and importance of documentation.

Unit I: Introduction to Electronic Product Design 6L

Man machine dialog and Industrial design, user-centered design, five element of successful design, cognition, ergonomics. Packaging and factors, design for manufacture, assembly and disassembly, wiring, temperature, vibration and shock. Safety, noise, energy coupling, grounding, filtering and shielding.

Unit II: Hardware Design & testing methods 6L

Design process. Identifying the requirements, formulating specifications, design specifications, Specifications verses requirements, System partitioning, Functional design, architectural design, Functional model verses architectural model. Prototyping. Performance and Efficiency measures. Formulating a test plan, writing specifications, Test procedure and test cases, Egoless design, design reviews. Module debug and test: black box test, white box test, grey box test.

Unit III:Software Design and Testing methods 6L

Types of Software. Waterfall model of software development. Models, metrics and software limitations. Risk abatement and failure preventions. Software bugs and testing. Good programming practice. User interface .Embedded, Real time software.
Unit IV: PCB design 6L
Fundamental Definitions, Standards. Routing Topology Configurations, Layer Stack up assignment, Grounding Methodologies, Aspect Ratio, Image Planes, Functional Partitioning, Critical frequencies, Bypassing and decoupling. Design techniques for ESD Protection, Guard Band implementation.
Unit V: Product Debugging and testing 6L
Steps of Debugging, Techniques for troubleshooting, characterization, Electromechanical components, passive components, active components, active devices, operational amplifier, Analog-Digital Conversion, Digital Components, Inspection and test of components, Simulation, Prototyping and testing, Integration, validation and verification. EMI & EMC issues.
Unit VI : Documentation 6L
Definition, need, and types of documentation. Records, Accountability, and Liability. Audience. Preparation, Presentation, and Preservation of documents. Methods of documentation, Visual techniques, Layout of documentation, Bill of material.
Text Books
1. Kim Fowler," Electronic Instrument Design" Oxford university press. 2. Robert J. Herrick, "Printed Circuit board design Techniques for EMC Compliance", Second edition, IEEE press.
Reference Books
1. James K. Peckol, "Embedded Systems – A Contemporary Design Tool", Wiley publication 2. J C Whitakar," The Electronics Handbook", CRC press.

404185 Artificial Intelligence (Elective II)				
Credits: 03 (TH)				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem : 70 Marks**

Course Objectives:

- To learn various types of algorithms useful in Artificial Intelligence (AI).
- To convey the ideas in AI research and programming language related to emergingtechnology.
- To understand the concepts of machine learning, pattern recognition, and natural language processing.
- To understand the numerous applications and huge possibilities in the field of AI that gobeyond the normal human imagination.

Course Outcomes:
On completion of the course, student will be able to

1. Design and implement key components of intelligent agents and expert systems.
2. To apply knowledge representation techniques and problem solving strategies to common AI applications.
3. Apply and integrate various artificial intelligence techniques in intelligent system development as well as understand the importance of maintaining intelligent systems.
4. Build rule-based and other knowledge-intensive problem solvers.

Course Contents

Unit I :Foundation (6 Hrs)

Intelligent Agents, Agents and environments, Good behavior, The nature of environments, structure of agents, Problem Solving, problem solving agents, example problems, Searching for solutions, uniformed search strategies, avoiding repeated states, searching with partial information.

Unit II :Searching (6Hrs)

Search and exploration, Informed search strategies, heuristic function, local search algorithms and optimistic problems, local search in continuous spaces, online search agents and unknown environments, Constraint satisfaction problems (CSP), Backtracking search and Local search for CSP, Structure of problems, Games: Optimal decisions in games, Alpha- Beta Pruning, imperfect real-time decision, games that include an element of chance.

Unit III :Knowledge Representation (6Hrs)

First order logic, representation revisited, Syntax and semantics for first order logic, Using first order logic, Knowledge engineering in first order logic, Inference in First order logic, prepositional versus first order logic, unification and lifting, forward chaining, backward chaining, Resolution, Knowledge representation, Uncertainty and methods, Bayesian Probability and Belief network, probabilistic Reasoning, Bayesian networks, inferences in Bayesian networks, Temporal models, Hidden Markov models.

Unit IV :Learning (6Hrs)

Learning from observations: forms of learning, Inductive learning, Learning decision trees, Ensemble learning, Knowledge in learning, Logical formulation of learning, Explanation based learning, Learning using relevant information, Inductive logic programming, Statistical learning methods, Learning with complete data, Learning with hidden variable, EM algorithm, Instance based learning, Neural networks - Reinforcement learning, Passive reinforcement learning, Active reinforcement learning, Generalization in reinforcement learning.

Unit V :Pattern Recognition and Expert System(6 Hrs)

Basic steps of pattern recognition system, Feature Extraction- Principal Component Analysis, Linear Discriminant Analysis, Classification, Object Recognition- Template Matching theory, Prototype Matching Theory, Speech Recognition, Pattern Mining- Apriori Algorithm,

Unit VI :Natural Language Understanding (6Hrs)

Why NL, Formal grammar for a fragment of English, Syntactic analysis, Augmented grammars, Semantic interpretation, Ambiguity and disambiguation, Discourse understanding, Grammar induction, Probabilistic language processing, Probabilistic language models

Text Books:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence", A Modern Approach, Pearson Education/Prentice Hall of India.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw-Hill.

Reference Books

404185 **Optimization techniques (Elective II)**				
Credits: 03 (TH)				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem : 70 Marks**

Course Objectives:

Course Outcomes:

Course Contents

Unit I :

Unit II :

Unit III :

Unit IV :

Unit V :

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Unit VI :

Text Books:

1.

404185 Electronics in Agriculture (Elective II)				
Credits: 03 (TH)				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem : 70 Marks**

Course Objectives:

- To inculcate the ability to recognize environmental problems and to provide solutions to agricultural sector.
- An over view of technology of advanced topics like DAS, SCADA and Virtual Instrumentation.
- The ability to select the essential elements and practices needed to develop and implement the Engineering Automation for Agricultural sector.

Course Outcomes:

After successfully completing the course students will be able to

- Understand Role of computers & virtual instrumentation.
- Provide communication solution for interpreting environmental parameters with Electronics systems.
- Describe Instrument technology used in agriculture.
- Apply knowledge of Electronics in Agriculture.
- Understand Greenhouse Technology & Role of Electronics Governance.

Course Contents

Unit I : **Review of computers & Virtual instrumentation** **6L**

Data loggers, Data acquisitions systems (DAS), Supervisory control and data acquisition (SCADA), Basics of PLC, Functional block diagram of computer control system, alarms, interrupts.Virtual Instrumentation: Historical Perspective, advantages, Block diagram and architecture of virtual instrument, data flow techniques, graphical programming in data flow, comparison with conventional programming.

Unit II : **Communication Systems** **6L**

Use of field buses, functions, international standards, field bus advantages and disadvantages, Instrumentation network: sensor networks, Open networks-advantages and limitations, HART Network, Foundation field bus network. Profibus PA: Basics, architecture, model, network design. Foundation field bus segments: General consideration, network design.

Unit III : **Instrument technology for agriculture** **6L**

Instrument for measurement of pH, Electrical conductivity, gas analysis, humidity, leaf area, chlorophyll content, and soil moisture & temperature.

Unit IV : **Precision Farming**	**6L**
An introduction to precision farming. GIS/GPS positioning system for precision farming, Yield monitoring and mapping, soil sampling and analysis. Computers and Geographic information systems. Precision farming- Issues and conditions. Role of electronics in farm machinery for precision farming.	
Unit V : **Electronics in Agriculture**	**6L**
Instrument for crop monitoring – moisture measurement – capacitive, infrared reflectance and resistance. Monitoring soil and weather – measurement of soil properties and meteorological parameters – irrigation control systems. Instruments for crop establishment monitoring. Crop spraying – selective crop spraying – flow control. Yield monitoring. Technology for precision farming. Instruments for protected cultivation – green house environment control – transducers and control system. Instruments and systems for crop handling processing and storage. ,	
Unit VI : **Applications & Electronics Governance**	**6L**
Greenhouse: History of modeling and control of Greenhouse, Identification of control and manipulation variables for Greenhouse. Crop Preservation : Importance of Preservation of various commodities and parts of plants, Drying process for preservation, Variable identification for drying process, Electronic control system for grape drying process. Agriculture & Electronics Governance: Governance products & services in agriculture sector, Role of Electronics Governance in Agricultural sector.	

Text Books:

1. Curtis Johnson, “Process Control Instrumentation Technology”; 8th Edition, Pearson Education

2.Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication

1. De Mess M. N. Fundamental of Geographic Information System. John Willy & sons, New York, Datta S.K.1987.
2. K. Krishna Swamy, “Process Control”; New Age International Publishers
3. Kuhar, John. E. 1977. The precision farming guide for agriculturalist. Lori J. Dhabalt, US

Manual of Soil & Water conservation Engineering. Oxford & IBH Co. Sigma & Jagmohan, 1976.

Lab Practice I

Credits: PR-02

Teaching Scheme:				Examination Scheme:
Practical : 04 hr/week				**Oral : 50 Marks** **Term-work :50 Marks**

List of the Experiments (Minimum 8 experiments are to be performed).

1. Implementation of LAN using suitable multiuser Windows operating System and demonstrating client-server and peer to peer mode of configuration.
2. Installation and configuration of Web server, FTP Server.
3. Study of DNS, SMTP & POP3 Determine the local host address, Ping to a host using its NetBIOS name Add IP addresses/host name mappings to the local host file Configure DNS service on Windows 2000 server Use Domain Name Service to resolve hostnames into IP addresses. Interact with an Email server using SMTP and POP3 protocols commands.
4. Installation and configuration of Telnet server for Telnet communication.
5. Installation and configuration of Proxy server.
6. Installation and configuration of DHCP server.
7. Study of IP Addresses subnetting and CIDR
8. Study of Network Protocol Analyzer tool/software.
9. Study of network monitoring tool/software.
10. Simulating LAN or WAN using suitable network simulator.
11. Write a program to simulate leaky bucket/token bucket.
11. Echo Client and Server Program Using TCP or UDP or both in C/Java
12. Write a program for Encryption and Decryption
13. Study of HTTPS, IPSec and SSH using Wireshark.

RMT

List of Experiments [Minimum 08]

Group A [Any 2]

1. To measure and compare radiation pattern, return loss, impedance, gain, beam width of dipole antenna and folded dipole antenna at microwave frequency

OR

1. To measure radiation pattern and gain of horn or parabolic antenna at microwave frequency
2. Design, simulate and compare performance of microwave dipole antennas of length 2λ, λ, λ/2 and λ/4.
3. Design, simulate and compare the performance of two element broad side and end fire uniform amplitude and uniformly spaced linear array.

Group B [Any 6]

4. To measure and plot mode characteristics of reflex klystron.
5. To measure VI characteristics of Gunn Diode and study of PIN modulator.
6. To measure and verify port characteristics of microwave tees (E, H, E-H or magic planes).
7. To measure and verify port characteristics of directional coupler and calculate coupling factor, insertion loss and directivity.
8. To measure and verify port characteristics of isolator and circulator and calculate insertion loss and isolation in dB.
9. To measure wavelength of the microwave using microwave test bench and verify with its theoretical calculations.
10. To plot standing wave pattern and measure SWR for open, short and matched termination at microwave frequency using slotted section with probe carriage.

Study the network analyzer and carry out the measurements of s-parameters.

304192 Laboratory Practice II				
Credits: PR-02				
Teaching Scheme:		**Examination Scheme:**		
Practical : 04 hr/week				**Practical : 50 Marks** **Termwork : 50 Marks**

Digital Image and Video Processing

List of Practical's

(Perform any 8 practical on appropriate software)

1. Perform basic operations on images.
2. Perform conversion between color spaces.
3. Perform histogram equalization.
4. Perform image filtering in spatial domain.
5. Perform image filtering in frequency domain.
6. Perform image restoration.
7. Perform image compression using DCT / Wavelet transform.
8. Perform edge detection using various masks.
9. Perform global and adaptive thresholding.
10. Apply morphological operators on an image.
11. Obtain boundary / regional descriptors of an image.
12. Extraction of frames from video, improve the quality and convert them back to compressed video.

Industrial Drives and Control

(Minimum 8 experiments are to be performed):

1. DC motor control using semi/full 1-Φ /3-Φ converter. (Open loop and closed loop)
2. 4-Quadrant chopper fed reversible DC drive
3. Dual converter fed DC Drive (Single phase/ Three phase)
4. Induction motor speed control using VFD
5. Speed Control of Universal Motor.
6. Stepper motor drive.
7. BLDC Motor drive.
8. Three phase brushless generator for wind energy applications.
9. Simulation of closed loop controlled DC motor drive using PSIM/Matlab/MathCad / open source software

10 Simulation of closed loop controlled AC motor drive using PSIM / Matlab/MathCad/ open source software

Embedded Systems & RTOS

Minimum 08 experiments

Any 02 Lab exercise from Sr.No 2,3,4

Any 01 Lab exercise from Sr.No 05,06

List of Practical's:

1. Porting of ucos-II on ARM7/Cortex controller.
2. Implementation/Verification of multitasking (minimum 03 tasks) with ucos-II on ARM7/Cortex controller.
3. Implementation of semaphore with ucos –II service ARM7/Cortex controller for resource management and synchronization.
4. Implementation of interprocess communication with ucos-II mailbox and message queue service on ARM7/Cortex controller.
5. Programming with exploring onchip ADC of Cortex /MSP430 based microcontroller.
6. Programming on motor control with exploring onchip PWM of Cortex based microcontroller.
7. Exercise on Porting of Linux on ARM board (ARM9 preferably)
8. Programming for device driver with Embedded Linux.
9. Programming with Arduino development for GPIO on Arduino Uno board.

Case study of any compute/communication/control application on Arduino Uno board

Internet of Things

A Project based Learning approach will be followed for this course hence the experiments will be small projects to be built by the students.

List of the Experimental Projects(Minimum 6 are to be performed):

1. Study& Survey of various development boards for IoT.

2. Study & Survey of various IoT platforms.

3. Interfacing sensors and actuatorswith Aurdino .

4. Build a cloud-ready temperature sensor with the Arduino Uno and the any IoT Platform: This project shows the building of a temperature sensor.

5. Interfacing Sensors and actuators with Raspberry Pi 2.

6. IoT based Stepper Motor Control with Raspberry Pi: The combination of Raspberry Pi and IoT is an exciting one. Raspberry Pi has many general purpose I/O pins and has the ability to control different actuators like stepper motors. In this project, an internet control of stepper motor using Raspberry Pi computer is developed. The connectivity is divided into server side software and client side software.

7.IoT based Web Controlled Home Automation using Raspberry Pi.

8. A Simple IoT Project with the ESP8266 WiFi module: Here is a simple project with ESP8266 wifi module.This project collects the temperature and is displayed on the network.

9. Implement a RFID Based IoT Project

Project Phase-I (404188)		
Teaching Scheme: Tutorial: 2Hrs/week		**Examination Scheme:** OR :50Marks

Note:

1. Term work assessment is based on the project topic. It consists of Literature Survey and basic project work. The abstract of the project should be submitted before Term work assessment.

2. The report consists of the Literature Survey, basic project work and the size of the report should be maximum of 40 pages.

3. The examination is conducted by two examiners (internal and external) appointed by the university. The examiners appointed must have minimum 5 years of experience with UG qualification or 2 years with PG qualification.

4. The assessment is based on Innovative Idea, Depth of understanding, Applications, Individual contributions, presentation, and the grade given by the internal guide based on the work carried out in a semester.

5. A certified copy of report is required to be presented to external examiner at the time of final examination.

Audit Course Green Energy				
Credits: 00				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

About the course

This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The students will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized

Course Objectives:

- To understand the conventional and non conventional energy sources
- To understand different renewable energy sources and their generation
- To understand the various applications & benefits of renewable energy sources
- To enable student to understand project management, energy audit and Installation

Course Outcomes:

After the successful completion of this course, the student is expected to have/be able to:

1. List and generally explain the main sources of energy and their primary applications in the India, and the world.
2. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
3. Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources.
4. List and describe the primary renewable energy resources and technologies.
5. Describe/illustrate basic electrical concepts and system components.
6. Convert units of energy—to quantify energy demands and make comparisons among energy uses, resources, and technologies.
7. Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

Unit 1: Introduction of conventional & renewable energy sources:

Environment aspects, Energy Efficient materials, Pollution Control techniques, Energy conservation, Energy Audits

Unit II: Details of renewable energy sources & various systems

Solar, Wind, Hydro, Bio-power, Waste to Power

Unit III: Various applications & benefits

Renewable power projects for smart cities & rural electrification, Power conversion techniques, Off-grid/Stand-alone systems, Grid connected systems, Design of Grid-tied & off-grid Solar PV systems, Design of Grid-tied & off-grid Wind systems, Design of Grid-tied & off-grid Hybrid systems, Storage technologies

Unit IV: Project management

Installation & commissioning techniques & standards, Remote monitoring & control techniques, Performance optimization & control, Practical's / Hands-on exposure, Maintenance & Service of plants, Government policies

Guidelines for Conduction (Any one or more of following but not limited to)

- Guest Lectures
- Group Activities
- Assignments
- Taking up small project for short duration

Guidelines for Assessment (Any one or more of following but not limited to)

- Practical Test
- Presentation
- Paper / (Theory assessment test)
- Report

Sources/ References:

1. Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450

pages (ISBN: 0-19- 926178-4).

2. Boyle, Godfrey, Bob Everett, and Janet Ramage (eds.) 2004. Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press, 619 pages (ISBN: 0-19-926179-2)

3. Ashok Desai V, *Non-Conventional Energy,* Wiley Eastern Ltd, 1990.

4. Mittal K.M, *Non-Conventional Energy Systems,* Wheeler Publishing Co. Ltd, 1997.

5. Ramesh R, Kurnar K.U, *Renewable Energy Technologies,* Narosa Publishing House,

New Delhi, 1997.

6. Renewable Energy Resources by John Twidell and Tony Weir.

Audit Course		**Human Behavior**		
Credits: 00				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

About the Course:

Human behavior is the responses of individuals or groups of humans to internal and external stimuli. It refers to the array of every physical action and observable emotion associated with individuals, as well as the human race. Social behavior is a subset of human behavior and includes the study of considerable influence of social interaction and culture. Additional influences include ethics, encircling, authority, rapport, hypnosis, persuasion and coercion.

The behavior of humans falls within a range with some behavior being common, some unusual, some acceptable, and some beyond acceptable limits. The acceptability of behavior depends heavily upon social norms and is regulated by various means of social control. Human behavior is experienced throughout an individual's entire lifetime. It includes the way they act based on different factors such as genetics, social norms, core faith, and attitude. An attitude is an expression of favor or disfavor toward a person, place, thing, or event.

Course Objectives:

- To develop understanding of Behavioral Aspects.
- To identify and develop Attitude and Core Faith values
- To expose students to Family Relations, time and career management
- To enable student to understand Creative Thinking and Problem solving
- To enable students to understand Humanistic Education.

Course Outcomes:

On completion of the course, society will observe –

- Change in awareness levels, knowledge and understanding of student
- Change in attitudes / behavior of students with regards to their education improved teamwork,
- institutional leadership and other life skills
- Improvement in social health and attitude.

Unit 1:

Why Human Relations are so important? Understanding Behavior, Human Relations, and Performance, Personality, Stress, Learning, and Perception, Attitudes, Self-Concept, Natural acceptance of human values, and Ethics, Dealing with Conflict, Leading and Trust.

Unit 2:

Time and Career Management, Interpersonal Communication, Organizational Structure and Communication, Team Dynamics and Leadership, Teams and Creative Problem Solving and Decision Making

Unit 3:

Understanding Harmony in the Family and Society, Harmony in Human Relationship, Understanding the meaning of *Vishwas*; Difference between intention and competence, Understanding the meaning of *Samman*; Difference between respect and differentiation. Understanding the harmony in the society: *Samadhan, Samridhi, Abhay, Sahasttva* as comprehensive Human Goals.

Unit 4:

Justice in Humankind, Nurturing and Exploitation, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics.

Reference Books:

1. “Human Relations in Organizations Applications and Skill Building” Robart Lussier, eighth edition, McGraw-Hill (2014).

2. Atkinson and Hilgard’s, “Introduction to psychology” Nolen-Hoeksema, S., Fredrickson, B. L., Loftus, G. R., & Lutz, C., Cengage Learning EME.

3. “A Foundation Course in Human Values and Professional Ethics” R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi and Teacher's Manual, R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi

4. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.

5. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

Semester-II

404189 **Mobile Communication**		
Teaching Scheme: Lectures: 3Hrs/ Week		**Examination Scheme:** In Semester Assessment: Phase I : 30 End Semester Examination: Phase II: 70

Course Objectives

- To understand switching techniques for voice and data traffic.
- To nurture students with knowledge of traffic engineering to design networks.
- To realize importance of cellular concepts and its propagation mechanism.
- To understand architecture of GSM system.
- To overview 4G LTE and 5G technologies.

Course Outcomes

After successfully completing the course students will be able to

- Apply the concepts of switching technique and traffic engineering to design multistage networks.
- Explore the architecture of GSM.
- Differentiate thoroughly the generations of mobile technologies.

Unit I - Switching techniques for Voice and Data (8)

Switching techniques for Voice: Manual Switching System, Electronic Switching System and Time Division Switching. Single Stage networks, Gradings, Two stage and Three stage networks. Synchronization, **Control of switching systems:** Call processing Functions, Common Control, Reliability, Availability and Security.

Switching techniques for Data: Circuit switching, Message Switching and packet Switching in perceptive with mobile communication.

Unit II - Traffic Engineering and Signalling (8)

Telecommunication Traffic: Unit of Traffic, Traffic measurement, A mathematical model, Lost- call systems: Theory, traffic performance, loss systems in tandem, traffic tables. Queuing systems: Erlang Distribution, probability of delay, Finite queue capacity, Systems with a single server, Queues in tandem, delay tables and application of delay formulae.

Signaling: Customer line signaling. FDM carrier systems, PCM signaling, Inter-register signaling, Common channel signaling, CCITT signaling system and Digital customer line signaling.

Unit III - Cellular Concept (8)

Introduction to cellular telephone system, Cellular concept : Expansion of mobile system capacity through frequency reuse, Cell geometry, Selection of cluster size, Cell splitting and sectoring, Coverage and capacity in cellular system and Handoff strategies.

Propagation Mechanism: Free space and two ray propagation model, Basic propagation mechanism. Hata outdoor propagation model. **Small Scale Fading and Multipath:** Types of Small scale fading, Small scale multipath propagation, Impulse response model of multipath channel and Small scale multipath measurements.

Unit IV - GSM Fundamentals (8)

Introduction, Architecture of GSM, characteristics of GSM standards, services, Radio transmission parameters in GSM System, Applications.

Unit V - GSM Channels and Services (8)

Traffic and Logical Channels in GSM, GSM time hierarchy, GSM burst structure, Description of call setup procedure, Handover mechanism in GSM, Security in GSM.

Data transmission in GSM: Data Services, SMS, HSCSD, GPRS, EDGE.

Multiple Access Techniques-TDMA, CDMA and OFDMA.

Unit VI - Evolution of Mobile Technologies (6)

Evolution of Mobile Generation and its comparison(GSM & CDMA)

Overview of LTE : LTE basics , LTE frame structure, LTE Design parameters with Standardization and Architecture of LTE.

Overview of 5 G Networks : Comparison of 4G and 5G technology, Opportunities and requirements in 5G network, Open Wireless Architecture of 5G network and Disruptive technologies for 5G.

Text Books

1. Fei Hu, “Opportunities in 5G Networks : A research& development perspective”, CRC Press
2. J. E. Flood , “Telecommunications Switching, Traffic and Networks”, Pearson Education
3. Theodore Rappaport, “Wireless Communications Principles and Practice” Second Edition, Pearson Education
4. ThiagarajanVishwanathan, “Telecommunication Switching Systems and Networks”; PHI Publications

Reference Books

1 Krzysztof Wesolowski, “Mobile Communication Systems”, Wiley Student Edition
2 John C. Bellamy, “Digital Telephony”, Third Edition; Wiley Publications

3 Mischa Schwartz, “Mobile Wireless Communications”, Cambridge University Press
4 Aditya Jagannatham,”Principles of Modern Wireless Communication Systems”

404190 Broadband Communication Systems

Credits: 04

Teaching Scheme:	**Examination Scheme:**
Lecture : 04 hr/week	**In-Sem : 30 Marks** **End-Sem : 70 Marks**

Course Objectives:

- To comprehend the three primary components of a fiber optic communication system.
- To understand the system design issues and the role of WDM components in advanced light wave systems.
- To understand the basics of orbital mechanics and the look angles from ground stations to the satellite.
- To apply subject understanding in Link Design.

Course Outcomes:

After successfully completing the course students will be able to:

- Perform Link power budget and Rise Time Budget by proper selection of components and check its viability.
- Perform Satellite Link design for Up Link and Down Link.

Course Contents

UNIT I: Light wave System Components (8L)

Key Elements of optical fiber system, Optical fibers as a communication channel: Optical fiber modes and configurations, Mode theory for Circular waveguides, Single mode fibers, Graded index fiber structure, Signal degradation in optical fibers. Optical sources: Basic concepts and characteristics of LEDs and LASERs. Photo detectors: Basic concepts, Common photo detectors.

UNIT II: Light wave Systems (6L)

System architectures, Point to point links: System considerations, Design guidelines: Optical power budget, Rise time budget, Long - Haul systems.

UNIT III: Multichannel Systems (6L)

Overview of WDM, WDM Components: 2 x 2 Fiber coupler, Optical isolators and circulators, Multiplexers and De-multiplexers, Fiber Bragg Grating, FBG applications for multiplexing and de-multiplexing function, Diffraction gratings, Overview of optical amplifiers: SOA, EDFA and RFA in brief.

UNIT IV: Orbital Mechanics and Launchers (8L)

History of Satellite communication, Orbital mechanics, Look angle determination, Orbital perturbations, Orbital determination, Launchers and launch vehicles, Orbital effects in communication system performance.

UNIT V: Satellite sub systems **(6L)**

Satellite Subsystems, Attitude and Control Systems (AOCS), Telemetry, Tracking, Command and monitoring, Power systems, Communication subsystems, Satellite antennas, Equipment reliability and space qualification.

UNIT VI: Satellite communication link design **(8L)**

Introduction, Basic transmission theory, System noise temperature and G/T Ratio, Design of downlinks, Satellite systems using small earth stations, Uplink design, Design of specified C/N: Combining C/N and C/I values in satellite links system design examples.

Text Books:

1. Gerd Keiser, "Optical fiber Communications", Tata McGraw Hill, 4th edition.
2. Timothy Pratt, Charles Bostian, Jeremy Allnutt, "Satellite Communications", John Wiley & Sons.

Reference Books:

1. Govind P. Agrawal, "Fiber -Optic Communication Systems", Wiley, 3rd edition.
2. Dennis Roody, "Satellite Communications", McGraw Hill

404191 Machine Learning (Elective III)

Credits: 03 (TH)

Teaching Scheme:	Examination Scheme:
Lecture : 03 hr/week	In-Sem : 30 Marks End-Sem: 70 Marks

Course Objectives:

- Explore supervised and unsupervised learning paradigms of machine learning used forregression and classification.
- To design and analyze various machine learning algorithms using neural networks
- To explore Deep learning technique and various feature extraction strategies.

Course Outcomes:

On completion of the course, student will be able to

1. To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
2. To mathematically analyze various machine learning approaches and paradigms.
3. To implement convolution neural networks in recognition applications.

Course Contents

Unit I :Introduction to Machine Learning **(4 Hrs)**

Why Machine learning. Types of machine learning, basic concepts in machine learning like parametric and non-parametricmodeling, linear and nonlinear regression, overfitting and dimensionality reduction. Decision trees, Feature reduction.

Unit II : Models for Regression and Classification (8Hrs)

Linear Models for Regression :Least SquaresandNearestNeighbors ,Linear Basis Function Models,The Bias-Variance Decomposition,Bayesian Linear Regression,Bayesian Model Comparison
Linear Models for Classification : Discriminant Functions .Probabilistic Discriminative Models
Multivariate Data,Parameter Estimation,Multivariate Classification,Multivariate Regression
Kernal Methods : Support Vector machines and Relevance Vector Machines

Unit III :Clustering (6Hrs)

Dimensionality Reduction : Principal Components Analysis,Factor Analysis,Multidimensional Scaling,Linear Discriminant Analysis Clustering : k-Means Clustering,Mixtures of Gaussians

Unit IV : Artificial Neural Networks I (6Hrs)

Biological neuron, Artificial neuron model, concept of bias and threshold, Activation functions, Mc Culloch-Pits Neuron Model, learning paradigms,concept of error energy, gradient descent algorithm and application of linear neuron for linear regression,: Learning mechanisms: Hebbian, Delta Rule, Perceptron and its limitations.

Unit V : Artificial Neural Networks II(6 Hrs)

Multilayer perceptron (MLP) and back propagation algorithm, Application of MLP for classification, Self-Organizing Feature Maps,Learning vector quantization Radial Basis Function networks.

Unit VI : Deep Learning and Convolution Neural Networks(6Hrs)

Improvement of the Deep Neural Network:Vanishing Gradient, Overfitting, Computational Load,ReLU Function, Dropout Architecture of ConvNet, Convolution Layer, Pooling Layer, Applications of CNN's.

Text Books:

1. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elementsof Statistical Learning", Springer 2009
3. LaureneFausett ," Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education, Inc, 2008
4. Phil Kim, "MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence",a Press 2017

Reference Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Ethem Alpaydın "Introduction to Machine Learning" Second Edition The MIT Press 2010
3. Simon Haykin," Neural Networks : A comprehensive foundation,, ,Prentice Hall International Inc1999

404191 PLC & Automation (Elective III)

Credits: 03

Teaching Scheme:	Examination Scheme:
Lecture : 03hr/week	In-Sem : 30 Marks End-Sem: 70 Marks

Course Objectives:

- Student will get the ability to recognize industrial control problems suitable for PLC control
- The learners will get an over view of technology of advanced topics such as SCADA, DCS Systems, DigitalController, CNC Machines.
- Student will gain the ability to select the essential elements and practices needed to develop and implement the Engineering Automation using PLC approach.

Course Outcomes:

On successful completion of the course, students able to:

1. Understand PLC architecture
2. Develop PLC ladder programs for simple industrial applications
3. Design Automation systems for industrial applications
4. Implement the Engineering Automation using PLC approach.

Course Contents

Unit I: Process Control & Automation **[6]**

Process control principles, Servomechanisms, Control System Evaluation, Analog control, Digital control, Types of Automation; Architecture of Industrial Automation Systems, Advantages and limitations of Automation, Effects of modern developments in automation on global competitiveness.

Unit II: Transmitters and Signal Conditioning **[6]**

Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Analog and Digital signal conditioning for RTD, Thermocouple, DPT etc , Smart and Intelligent transmitters.

Unit III: Controllers and Actuators **[6]**

PID Controller, Cascade PID control, Microprocessor Based control, PAC (Programmable automation controller), Mechanical switches, Solid state switches,Electrical actuators: Solenoids, Relays and Contactors, AC Motor, VFD, energy conservation schemes through VFD, DC Motor, BLDC Motor, Stepper Motor, Servo Motor, Pneumatic and hydraulic actuators.

Unit – IV Introduction to PLC **[6]**

PLC: Characteristics, Operation, function, Types of PLC, Architecture Of PLC, Applications of PLC, PC v/s PLC, PLC programming, Ladder diagram: of logic gates, multiplexer, Ladder diagram for different logical conditions or logical equations or truth table. Timers: types of timer, Characteristics, Function of timer in PLC, Classification of a PLC timer, Ladder diagram using timer, PLC counter, Ladder diagram using counter.

Unit – V Industrial Automation **[6]**

Basic Concept, History and Hierarchy of DCS, Functions of each level, Advantages and Disadvantages, Architecture of SCADA , MTU- functions of MTU, RTU- Functions of RTU, Working of SCADA, Comparison, suitability of PLC, DCS and SCADA, Applications: Thermal power plant, Irrigation and Cement factory.

Unit VI: Automation and CNC (Computer Numeric Control) Machines[7]

Introduction of CNC Machines: Basics and need of CNC machines, NC, CNC and DNC (Direct NC) systems, Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines. Industrial Communication:Devicenet, Interbus , Device network: Foundation Fieldbus -H 1, HART, CAN, PROFIBUS-PA, Control network: ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP. Panel Engineering for Automation

Text Books:

1. Curtis Johnson, "Process Control Instrumentation Technology"; 8th Edition, Pearson Education.
2. MadhuchhandaMitra, SamarjitSen Gupta, "Programmable Logic controllers and Industrial Automation"; Penram International Publishing India Pvt. Ltd.

Reference Books:

1. Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication.
2. John W. Webb, Ronold A Reis, "Programmable Logic Controllers, Principles and Applications"; 5th Edition, Prentice Hall of India Pvt. Ltd.
3. Kilian, "Modern control technology: components & systems, Delmar 2nd edition.
4. Bela G Liptak, Process software and digital networks, 3rd edition, 2002.
5. Pollack. Herman, W & Robinson., T. "Computer Numerical Control", Prentice Hall. NJ.
6. Pabla, B.S. &Adithan, M. "CNC Machines", New Age Publishers, New Delhi

404191 Audio and Speech Processing (Elective III)

Credits: 03

Teaching Scheme			Examination Scheme	
Lecture : 03 hr/week				In-Sem: 30 Marks End-Sem: 70 Marks

Course Objectives:

- To understand basics of speech production and perception mechanism.
- To understand classification of speech sounds based on acoustic and articulatory phonetics.
- To understand the motivation of short-term analysis of speech and audio.
- To understand various audio and speech coding techniques.
- To perform the analysis of speech signal using LPC.
- To extract the information of the speech or audio signals in terms of cepstral features.
- To provide a foundation for developing applications in the field of speech and audio processing.

Course Outcomes:

On completion of the course, student will be able to

- Design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing.
- Analyze speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).
- Analyze speech signal for extracting LPC and MFCC Parameters of speech signal.
- Apply the knowledge of speech and audio signal analysis to build speech processing applications like speech coding, speech recognition, speech enhancement and speaker recognition/verification.

Course Contents

Unit I : Fundamentals of speech production **(6 Hrs)**

Anatomy and physiology of speech production, Human speech production mechanism, LTI model for speech production, Nature of speech signal, linear time varying model, articulators, articulatory phonetics, manner of articulation, place of articulation, acoustic phonetics, spectrogram, classification of speech sounds: vowels, semivowels, nasal diphthongs, stops, affricates, fricative, vowel triangle.

Unit II : Human auditory system and speech perception **(6 Hrs)**

Anatomy and physiology of the ear, outer ear, middle ear and inner ear. Human auditory system, simplified model of cochlea. Sound perception, Auditory psychophysics, thresholds, just noticeable differences (JNDs), Sound pressure level and loudness. Sound intensity and Decibel sound levels. Pitch perception, masking, Concept of critical band and introduction to auditory system as a filter bank, Uniform, non-uniform filter bank, mel scale and bark scale. Speech perception: vowel perception. Coarticulation effects. Consonant perception, perception of manner of articulation feature. Perception of place of articulation.

Unit III: Time and frequency domain methods for speech and audio signal analysis.

(6Hrs)

Time-dependent speech processing. Short-time energy, short time average magnitude, Short time average zero crossing rate. Speech Vs. silence discrimination using energy and zero crossing rate. Short-time autocorrelation function, short-time average magnitude difference function. Pitch period estimation using autocorrelation method. Audio feature extraction, Spectral centroid, spectral spread, spectral entropy, spectral flux, spectral roll-off. Spectrogram: narrow band and wide band spectrogram.

Unit IV : Linear prediction and cepstral analysis **(6 Hrs)**

Basic principles of linear predictive analysis. Autocorrelation method, covariance method. Solution of LPC equations: Durbin's recursive solution, lattice formulations and solutions. Frequency domain interpretation of LP analysis. Applications of LPC parameters as pitch detection and formant analysis

Homomorphic processing of speech signal, application of cepstral analysis for vocal tract vocal cord parameter estimation (formants and pitch). Computation of MFCC.

Unit V : Speech and Audio coding

(6Hrs)

Time domain waveform coding: linear PCM, companded PCM, DPCM, DM, ADM.

Spectral coders: Filter bank analysis, sub-band coders, Adaptive transform coders (ATC), Harmonic coding. Linear predictive coders (LPC), Non-LP source voice coders: phase vocoders, channel vocoders, excitation for vocoders, Homomorphic (Cepstral) vocoders. Speech coding standards and applications.

Unit VI : Digital speech processing for man-machine communication (6 Hrs) Automatic speech recognition (isolated word recognition, automatic telephone number dialing system etc. using statistical signal modeling e.g. GMM, GMM-HMM), Linear and dynamic time warping, text to speech synthesis, speaker recognition and verification, speech enhancement, Introduction to Musical instrument classification, Musical Information retrieval.
Text Books: 1. L. R. Rabiner and S.W. Schafer, "Digital processing of speech signals" Pearson Publication. 2. Douglas O'Shaughnessy, "Speech Communications: Human and Machine:, 2nd Edition Universities Press.
Reference Books: nas F. Quateri , "Discrete-Time Speech Signal Processing: Principles and Practice" 1. a Apte, "Speech and audio processing", Wiley India Publication Gold and Nelson Morgan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", Wiley India. 4. L. R. Rabiner , B. H. Juang and B. Yegnanarayana "Fundamentals of speech recognition". Pearson Publication

404191 Software Defined Radio (Elective III)

Credits: 03				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- To understand "Modern Radio Communication System " that can be reconfigured
- To understand GNU Radio
- To understand how SDR platform provides easy access to wireless network system
- To understand how unlike simulation in Communication Projects, SDR allows easy
- access to both PHY and MAC layer
- To understand the concept of Cognitive Radio and Spectrum sharing

Course Outcomes:

On completion of the course, student will be able to

1) Compare SDR with traditional Hardware Radio HDR

2) Implement modern wireless system based on OFDM, MIMO & Smart Antenna

3) Build experiment with real wireless waveform and applications, accessing both PHY and MAC, Compare SDR versus MATLAB and Hardware Radio

4) Work on open projects and explore their capability to build their own communication System.

Course Contents

Unit I : Introduction to SDR and RF Implementation **(6Hrs)**

Introduction to SDR, Need of SDR, Principles of SDR , Basic Principle and difference in Analog radio and SDR , SDR characteristics, required hardware specifications, Software/Hardware platform, GNU radio -What is GNU radio, GNU Radio Architecture, Hardware Block of GNU,GNU software , MATLAB in SDR , Radio Frequency Implementation issues, Purpose of RF front End, Dynamic Range ,RF receiver Front End topologies, Flexibility of RF chain with software radio, Duplexer ,Diplexer ,RF filter ,LNA ,Image reject filters , IF filters , RF Mixers Local Oscillator , AGC, Transmitter Architecture and their issues, Sampling theorem in ADC, Noise and distortion in RF chain, Pre-distortion

Unit II :SDR Architecture **(7Hrs)**

Architecture of SDR-Open Architecture, Software Communication Architecture, Transmitter Receiver Homodyne/heterodyne architecture, RF front End, ADC, DAC, DAC/ADC Noise Budget, ADC and DAC Distortion, Role of FPGA/CPU/GPU in SDR, Applications of FPGA in SDR, Design Principles using FPGA, Trade –offs in using DSP, FPGA and ASIC, Power Management Issues in DSP, ASIC, FPGA

Unit III : Multi Rate Signal Processing **(6 Hrs)**

Sample timing algorithms, Frequency offset estimation and correction, Channel Estimation, Basics of Multi Rate, Multi Rate DSP, Multi Rate Algorithm, DSP techniques in SDR, OFDM in SDR

Unit IV : Smart/MIMO Antennas using Software Radio **(6 Hrs)**

Smart Antenna Architecture, Vector Channel Modeling , Benefits of Smart Antenna Phased Antenna Array Theory, Adaptive Arrays, DOA Arrays, Applying Software Radio Principles to Antenna Systems, Beam forming for systems-Multiple Fixed Beam Antenna Array, Fully Adaptive Array , Relative Benefits and Trade-offs OF Switched Beam and Adaptive Array, Smart Antenna Algorithms , Hardware Implementation of Smart Antennas, MIMO -frequency, time, sample Synchronization, Space time block coding-Space Time Filtering, Space Time Trellis Coding .

Case Study : Principles of MIMO-OFDM

Unit V : Cognitive Radio **(6Hrs)**

Cognitive Radio Architecture, Dynamic Access Spectrum, Spectrum Efficiency, Spectrum Efficiency gain in SDR and CR ,Spectrum Usage, SDR as a platform for CR, OFDM as PHY layer ,OFDM Modulator, OFDM Demodulator, OFDM Bandwidth, Benefits of OFDM in CR, Spectrum Sensing in CR, CR Network

Unit VI : Applications of SDR **(7Hrs)**

Application of SDR in Advance Communication System-Case Study, Challenges and Issues, Implementation, Parameter Estimation –Environment, Location, other factors, Vertical Handoff, Network Interoperability.

Case Study : 1)CR for Public Safety –PSCR , Modes of PSCR, Architecture of PSCR

2)Beagle board based SDR 3)Embedded PCSR using GNU radio

Text Books:

1. Jeffrey. H. Reed ,Software Radio : A Modern Approach to Radio Engineering , Pearson , LPE

Reference Books:

1. Markus Dillinger , Kambiz Madani, Nancy Alonistioti, Software Defined Radio :Architectures , Systems and Functions ,Wiley
2. Tony .J. Rouphael , RF and DSP for SDR, Elsevier Newness Press ,2008
3. Dr. Taj Struman ,Evaluation of SDR –Main Document
4. SDR –Handbook , 8th Edition , PENTEK
5. Bruce a. Fette , Cognitive Radio Technology, Newness, Elsevier

404191 Audio Video Engineering (Elective III)

Credits: 03

Teaching Scheme:		**Examination Scheme:**

Lecture : 03hr/week			In-Sem : 30 Marks End-Sem : 70 Marks

Course Objectives:

- After learning AVE course, students will get benefit to learn and understand the working of real life video system and the different elements of video system plus the encoding/decoding techniques.
- The learners will be groomed up to understand different channel allocations, difference between various systems present in this world, their transmission and reception techniques.
- Students will get insight on functioning of individual blocks, different standards of compression techniques and they will be acquainted with different types of analog, digital TV and HDTV systems.
- The students will get overview of fundamentals of Audio systems and basics of Acoustics

Course Outcomes:

On successful completion of the course, students able to:

1. Apply the fundamentals of Analog Television and Colour Television standards.
2. Explainthe fundamentals of Digital Television, DTV standards and parameters.
3. Study and understand various HDTV standards and Digital TV broadcasting systems and acquainted with different types of analog, digital TV and HDTV systems.
4. Understandacoustic fundamentals and various acoustic systems.

Course Contents

Unit I: Fundamentals of Colour Television 8L

The basic Television system and scanning principles, Composite video signal and television standards, Color TV systems, fundamentals, mixing of colours, colour perception, chromaticity diagram. NTSC, PAL, SECAM systems, colour TV transmitter, (high level, low level), colour TV receivers.

Unit II: Digital TV and Display Devices 6L

Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters, MAC signals, advanced MAC signal transmission, Digital TV receivers, Basic principles of Digital Video compression techniques, MPEG Standards. Digital TV recording techniques, Display devices: OLED, LCD, TFT, Plasma, Camcoder, Digicam.

Unit III: HDTV 6L

HDTV standards and systems, HDTV transmitter and receiver/encoder, Digital TV satellite Systems, video on demand, CCTV, CATV, direct to home TV, set top box with recording facility, conditional access system (CAS), 3D TV systems, HD video cameras, Digital broadcasting, case study (Cricket match, Marathon, Football match).

Unit IV: Advanced TV Systems 6L

IP Audio and Video, IPTV systems, Mobile TV, Video transmission in 3G/4G mobile System, Digital Video Recorders, Wi-Fi Audio / Video Transmitter and Receivers.

Unit V: Fundamentals of Audio-Video Recording 8L

Methods of sound recording & reproduction, optical recording, CD recording, audio standards. Digital Sound Recording, CD/ DVD player, MP3 player, Blue Ray DVD Players, MP3 Player.

Unit VI: Fundamentals of Acoustics 6L

Studio acoustics & reverberation, P.A. system for auditorium, acoustic chambers, Cordless microphone system, special types of speakers & microphones, Digital Radio Receiver Satellite radio reception.

Text Books

1. Television and video Engineering, A. M. Dhake, TMH Publication.
2. Audio Video Systems, R.G. Gupta, TMH Publication

Reference Books

1. R. R. Gulati, "Monochrome and colour television"
2. S. P. Bali, "Color TV Theory and Practice".
3. Bernard Grobb, Charles E, "Basic TV and Video Systems".
3. Video Demisified, Kelth jack, Penram International Publication.
4. Television Engineering Audio and Video Systems, D. S. Bormane/P.B. Mane/Itkarkar, Wiley publication.

404192 ROBOTICS (Elective-IV)

Credits: 03

Teaching Scheme:				**Examination Scheme:**
Lecture : 03hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- To understand the history, concept development and key components of robotics technologies.
- To understand basic mathematics manipulations of spatial coordinate representation and transformation.
- Able to solve basic robot forward and inverse kinematic problems
- To understand and able to solve basic robotic dynamics, path planning and control problems

Course Outcomes:
On completion of the course, student will be able to

1. Familiar with the history, concept development and key components of robotics technologies.
2. Implement basic mathematics manipulations of spatial coordinate representation and transformation.
3. Solve basic robot forward and inverse kinematic problems
4. Understand and able to solve basic robotic dynamics, path planning and control problems

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Course Contents

Unit I :Basic concepts in robotics **(6Hrs)**

Definition ; anatomyof robot, basic structure of robot, Specifications and Classification of robot, Safety Measures in robotics ,Industrial Applications of Robots.

Unit II :Robot drivers ,Sensors and Vision **(6Hrs)**

Drives for robots: Electric, hydraulic and pneumatic.

Sensors: Internal-External,Contact-noncontact, position, velocity,force, torque, proximity and range.

Vision: Introduction to techniques, Image acquisition and processing

Unit III : End Effectors and Actuators **(6Hrs)**

Different types of grippers- Mechanical,Magnetics,vacuum,Adhesive, Gripper force Analysis&Gripper Design , overview of actuators, Power and torque , Acceleration and velocitySpecifications and characteristics of Stepper motors, AC motors, DC motors and servomotors.

Unit IV : Robot Kinematics and Dynamics **(8Hrs)**

Direct and inverse kinematics for industrial robots for position and orientation, Redundancy, Manipulator, direct and inverse velocity. Lagrangian formulation , Link inertia tensor and manipulator inertia tensor, Newton –Eller formulation for RP and RP manipulators, Trajectory planning, interpolation, static force and moment transformation, solvability, stiffness

Unit V :Programming methods **(6Hrs)**

Robot language classification, Robot language structure, elements and its functions. Simple programs on Sensing distance and direction., Line Following Algorithms, Feedback Systems Other topics on advance robotic techniques

Unit VI : Developing and building a robot **(6Hrs)**

Models of flexible links and joints, Robotic arm – Components and structure, Types of joints and workspace, Design models for mechanic arms and lifting systems

Case Study: 1. Robots in material handling and assembly.

2. Human Robot Interaction

Text Books:

1. Introduction to Robotics By S.K.Saha , Tata McGraw Hill
2. Robotics Control ,Sensing ,Vision and Intelligence by K.S. Fu, R.C .Gonzalez, C.S.G.Lee , Tata McGraw Hill

Reference Books:

1. J. Hirchhorn: Kinematics and Dynamics of Machinery, McGraw Hill book co.
2. Robert J. Schilling , Fundamentals of Robotics- Analysis and Control, Prentics Hall india.
3. Robotics Technology and Flexible Automation by S.R.Deb, S. Deb, Tata McGraw Hill
4. Robot Motion and Control (Recent Developments) by M.Thoma & M. Morari

404194 Biomedical Electronics (Elective-IV)

Credits: 03

Teaching Scheme:		Examination Scheme:

Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

Course Objectives:

- To study Human Physiological Systems from Engineering Perspectives
- To understand the basic signals in the field of biomedical.
- To study origins and characteristics of some of the most commonly used biomedical signals, including ECG, EEG, PCG, Pulse
- To understand Sources and characteristics of noise and artifacts in bio signals.
- To understand use of bio signals in diagnosis, patient monitoring and physiological investigation

Course Outcomes:

After successfully completing the course students will be able to:

1. Model a biomedical system.
2. Understand various methods of acquiring bio signals.
3. Understand various sources of bio signal distortions and its remedial techniques.
4. Get an Overview of major Devices currently used in Medical field
5. The students will have an understanding of analyzing bio-signal and classifying them

Course Contents

Unit I : Introduction to Biomedical System

Biomedical Instrumentation System, Cell structure, Bio-Cell potential , Concept of Bio-electrodes, Types of Bio-electrodes to measure Bio-signal, Transducers and Sensors to measure Bio signal EEG,ECG,EMG, Respiration, Body temperature, SPO2, and Pulse. Artifacts in Bio signal Acquisition: Noise, Power line, Baseline, Skin Impedance and Motion Artifacts, Techniques to reduce the artifacts. **(6 Hrs)**

Unit II: Cardiovascular System

Introduction to Heart**,** Physiology and anatomy of Heart, Lead Configurations to acquire ECG, ECG preamplifiers, ECG recorder, Heart Sounds and Murmurs, Phonocardiography **(6Hrs)**

Unit III :Nervous System

Nerve Cell and nerve potential, Neural Communication, Brain structure, 10-20 electrode placement for EEG , Types of Montage configuration, Types of EEG signals and its significance, EEG machine, EEG applications for Epilepsy and Sleep apnea**.** **(6Hrs)**

Unit IV : Medical Instrumentation **(8Hrs)**

Design of Instrumentation system for ECG acquisition, Isolation Amplifier, Right Leg drive Mechanism, Noise removal techniques using Active Filters, Wiener Filters, Adaptive Filters: Basic Concept, Principle noise cancellation model, removal of periodic events, using adaptive cancellation, adaptive cancellation of maternal ECG from fetal ECG of Interest. Grounding and shielding Concepts

Unit V : Analysis of Electrical Activity of Heart **(6Hrs)**

ECG Signal Processing: Removal of Base line and Power line Interference, Muscle noise Filtering, Highlight ECG feature points, QRS detection, ECG classification for normal and abnormal state using Multilayer Perceptron. Use of Multiscale analysis for ECG parameter estimation.

Unit VI:Medical Devices **(4Hrs)**

Introduction To Blood Pressure Measurement (noninvasive), Life saving Devices Pacemakers and Defibrillators, Bedside Monitors, Central Monitoring system, Stress Test System, X Ray, CT scan , Dental instruments

Text Books:

- Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Prentice Hall, 2000.
- R. Rangayan, "Biomedical Signal Analysis", Wiley 2002.
- R.S.Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003, Edition-II.

Reference Books:

- John L Semmlow, "Bio-signal and Biomedical Image Processing", Marcel Dekker
- Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4thEdition, Prentice Hall, 2000.

404194 Wireless Sensor Networks (Elective-IV)

Credits: 03

Teaching Scheme:	Examination Scheme:
Lecture : 03 hr/week	In-Sem : 30 Marks End-Sem: 70 Marks

Course Objectives:

- To learn basic concepts of Wireless sensor networks
- To be familiar with architecture and protocols used in Wireless sensor networks
- To provide knowledge of deployment and security issued of Wireless sensor networks

Course Outcomes:

On completion of the course, student will be able to

1)Explain various concepts and terminologies used in WSN

2) Describe importance and use of radio communication and link management in WSN

3) Explain various wireless standards and protocols associated with WSN

4) Recognise importance of localisaion and routing techniques used in WSN

5) Understand techniques of data aggregation and importance of security in WSN

6) Examine the issues involved in design and deployment of WSN

Course Contents

UNIT1 : INTRODUCTION **[6]**

What are Wireless Sensor Networks, Wireless Sensor Node, Anatomy of a Sensor Node, architecture of WSN , Performance metrics in WSNs, types of WSN

UNIT 2: RADIO COMMUNICATION AND LINK MANAGEMENT **[7]**

Radio Waves and Modulation/Demodulation, Properties of Wireless Communications, Medium Access Protocols, Wireless Links Introduction, Properties of Wireless Links, Error Control, Naming and Addressing, Topology Control

UNIT 3: WIRELESS STANDARDS AND PROTOCOL STACK **[7]**

WSN Standards- IEEE802.15.4 Low rate WPAN, Zigbee, WirelessHART, ISA 100.11a, 6LoWPAN,IEEE802.15.3, Wibree,BLE, Zwave, ANT, Insteon, Wavenis, Protocol stack of WSNs, Cross Layer Protocol Stack

UNIT 4: LOCALIZATION AND ROUTING **[7]**

Localization : Localization Challenges and Properties, Deployment Schemes, Proximity Schemes. Ranging Schemes, Range-Based Localization, Range-Free Localization,
Routing Basics, Routing Metrics, Routing Protocols, Full-Network Broadcast, Location-Based Routing, Directed Diffusion, Collection Tree Protocol, Zigbee, Multi-Hop Communications:

UNIT 5: DATA AGGREGATION and SECURITY **[7]**

Clustering Techniques, In-Network Processing and Data Aggregation, Compressive Sampling, Security Issues in Wireless Sensor Networks, Attacks, Defensive Measures, Securityrequirements and threat model,

UNIT 6: DESIGNING AND DEPLOYING WSN APPLICATIONS **[6]**

Designing and Deploying WSN Applications,Early WSN Deployments, General Problems, General Testing and Validation, Requirements Analysis, The Top-Down Design Process, Bottom-Up Implementation Process,

404194 **Renewable Energy Systems (Elective-IV)**				
Credits: 03				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03hr/week				**In-Sem : 30 Marks** **End-Sem : 70 Marks**

Course Objectives:

- To study energy generation, different energy sources and their utilization and impact on environment
- To gain knowledge of solar radiation and its applications
- To understand the wind energy and its nature
- To analyze the performance of solar collectors and wind turbines
- To learn fuel cell and its efficiency

Course Outcomes:

On successful completion of the course, students able to:

- Interpret energy reserves of India and potential of different energy sources.
- Measure the solar radiation parameters and performance of different solar collectors.
- Calculate different parameters of wind turbine rotor.
- Implicit the importance and applications of geothermal and ocean energy.
- Demonstrate knowledge in field of fuel cell and potential for power generation.

Course Contents

Unit I : Energy Resources and Utilization: **(6Hrs)**

Conservation and forms of energy, energy reserves in India, nuclear power, hydroelectric power potential, India's power scene, impact on environment, renewable energy sources, energy parameters, cogeneration, rational energy use of energy, energy efficiency and conservation, new technologies, distributed energy systems and dispersed generation.

Unit II :Solar Energy **(8Hrs)**

Solar constant, spectral distribution of extraterrestrial radiation, terrestrial solar radiation, solar radiation geometry, computation of COSθ, sunrise, sunset, day length, LAT, Empirical equation, solar radiation measurement, Solar Thermal energy collectors, design parameters,laws of thermal radiation, radiation heat transfer between real bodies, radiation optics, transmitivity, heat losses and coefficient, Solar Thermal energy storage.

Unit III : Solar photovoltaic systems& Solar Applications **(8Hrs)**

Solar photovoltaic systems: Photovoltaics, Different types of PV Cells, Mono-poly crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems

Solar Applications: Solar water heating, solar distillation, solar ponds, solar pumping system, solar cooker, solar green house.

Unit IV : Wind energy **(8Hrs)**

Classification, types of rotors, terminology, operation of wind turbines, wind energy extraction, wind characteristics, wind speed, energy estimation, power density duration curve, density function, field data analysis, direction and wind speed, variation of wind speed, wind scale, energy pattern factor in wind power studies, land for wind energy, design of wind turbine rotor, regulating system, wind power generation curve, horizontal axis wind turbine generator, modes of wind power generation, advantages and disadvantages, wind energy farms.

Unit V : Ocean and Geothermal Energy **(6Hrs)**

Ocean Energy: Tidal Energy, Tidal characteristics, Tidal Energy estimation, Development of a tidal power scheme,Wave energy- characteristics-energy and power from the waves.

Geothermal energy: Structure of earth's interior, sites, field, gradient, resources, power generation, geothermal resources in India, utilization, global status of electricity generation from geothermal resources, advantages of geothermal energy

Unit VI : Fuel Cells **(6Hrs)**

Principle of operation of an acidic Fuel Cell, Technical parameter, Fuel Processor, methanol fuel cell, fuel cell types, Advantages of fuel cell power plants, comparison between acidic and alkaline hydrogen-oxygen fuel cells, state of art fuel cells, energy output of a fuel cell, efficiency and EMF of a fuel cell, Gibbs-Helmholtz equation, operating characteristics of fuel cells.

Text Books:

1. D.P. Kothari, K.C. Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", Prentice Hall of India, New Delhi, 2009.

Reference Books:

- Chetan Singh Solanki, "Renewable Energy Technologies", Prentice Hall of India, New Delhi, 2009
- G. D. Rai, "Non- conventional Energy Sources", Khanna publishers, New Delhi, 2011.
- MaltiGoel, "Energy Souces and Global Warming", allied publishers Pvt Ltd. New Delhi, 2005.
- S.P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", TMH, New Delhi, 2008.

Laboratory Practice III

Credits: PR-02				
Teaching Scheme:			**Examination Scheme:**	
Practical : 02 hr/week				**Oral : 50 Marks**

Mobile Communication:

List of Practical's: (Any Eight)

1. Perform an experiment to explain PSTN TST switch.
2. Write a program to elaborate Lost call system/ delay system used in the analysis of voice/data traffic.
3. Write a program to measure bit error rate in presence of AWGN model.
4. Write a program to simulate speech coding and decoding technique used in mobile Communication.
5. Set up and carry out experiment on AT commands for call operation.
6. Write a program to simulate experiment on GMSK modulation.
7. Write a program to measure bit error rate in presence of Hata/ Multipath propagation model.
8. Set up and carry out experiment to explain VoIP call routing process.
9. Visit to Mobile Telephone Switching Office (MTSO).
10. Perform an experiment / Simulate to elaborate the operation of Multiple access techniques such as TDMA/CDMA/OFDMA.

Broadband Communication System:

List of the Experiments:

- **Minimum 8 experiments are to be performed excluding tutorials.**
- **Tutorials are mandatory. (Expt. 5 and 12)**

1. Estimation of Numerical aperture of fiber.
2. Plot the characteristics of various sources and detectors.
3. Measure attenuation of MMSI and SMSI fiber and comment on the result based on attenuation due to increase in length as well as loss due to bend.
4. Set up a digital link and analyze.
5. Tutorial on Power budget and time budget analysis of optical fiber system.
6. Establishing a direct communication link between Uplink Transmitter and Downlink Receiver using tone signal.
7. To set up an Active Satellite link and demonstrate Link Fail Operation.
8. To establish an AUDIO-VIDEO satellite link between Transmitter and Receiver.
9. To communicate VOICE signal through satellite link.
10. To transmit and receive three separate signals (Audio, Video, Tone) simultaneously through satellite Link.
11. To transmit and receive PC data through satellite link.
12. Tutorial on satellite link design
13. Students, as a part of their term work, should visit satellite earth station and submit a report of visit. (Optional).

Laboratory Practice IV (Elective III)

Credits: PR-01				
Teaching Scheme:			**Examination Scheme:**	
Practical : 02 hr/week				**Oral : 50 Marks**

Machine Learning

List of Practical's:

(Use appropriate Software available in the Institute)

1. Implement simple logic network using MP neuron model
2. Implement a simple linear regressor with a single neuron model
3. Implement and test MLP trained with back-propagation algorithm
4. Implement and test RBF network
5. Implement SOFM for character recognition.
6. Implement SVM classifier for classification of data into two classes. Student can use datasets such as flower classification etc.
7. Implement and test Multiclass SVM classifier.
8. Implement and test CNN for object recognition.

PLC & Automation

List of Experiments (Minimum 8 experiments are to be performed).

1. Control the speed of servo motor using analog voltage 0-10V.
2. Rotate the servo motor according to X, Y co-ordinates.
3. Temperature detection using RTD & control the temperature of water at desired set point.
4. Control the flow of water using analog control valve.
5. Control the speed of AC 3ϕ motor using VFD.
6. Design simulation of 3 cylinder piston pump using pneumatic kit & PLC.
7. Detect the angle of shaft using Encoder & PLC.
8. Control the speed of 3ϕ AC motor from Mobile/HMI with PLC.
9. Interfacing of RFID with PLC & show the corresponding user data on SCADA to access the control.
10. Interface PLC with RTU & SCADA at remote location.
11. Exchange the data between two PLC's using Ethernet.
12. Interfacing of PLC to VFD over profibus & exchange the data.

Elective III: Audio and Speech Processing

List of Experiments (Minimum 8 experiments are to be performed):

NOTE: To perform the experiments software like MATLAB, SCILAB or any appropriate open source software can be used. For analysis of speech signals tools like PRAAT, Audacity can be used. Open source software is encouraged.

1. Record speech signal (isolated words, continuous speech) and analyze the speech signal using speech analysis tool (e.g. PRAAT). Observe spectrogram, pitch, formants, intensity etc.
2. Write a program to compute short time Energy and ZCR for different frame rates and comment on the result.
3. Write a program to classify voiced, unvoiced and silence frames using frame level energy and zero crossing rate
4. Write a program to compute narrow band and wide band spectrogram. Comment on the time and frequency resolution of wide band and narrow band spectrogram.
5. Write a program for extracting pitch period for a voiced part of the speech signal using autocorrelation method and average magnitude difference function (AMDF).
6. Write a program to design a Mel filter bank and using this filter bank write a program to extract MFCC features.
7. Write a program to perform the cepstral analysis of speech signal and detect the pitch from the voiced part using cepstrum analysis.
8. Write a program to find LPC coefficients using Levinson Durbin algorithm.
9. Write a program to enhance the noisy speech signal using spectral subtraction method.
10. Write a program to extract frequency domain audio features like SC, SF and Spectral roll off.

SDR

List of the Experiments(Minimum 8 experiments are to be performed):

1. Introduction to GNU Radio
2. Introduction to Software Defined Radio Systems
3. Implementation of AM using SDR
4. Implementation of FM using SDR with application such as transfer of files
5. Implementation of M-PSK transmitter using SDR
6. Implementation of M-PSK receiver using SDR
7. Implementation of M-QAM transmitter using SDR
8. Implementation of M-QAM receiver using SDR
9. Implementation of Transmission of files on Wireless media using SDR
10. Implementation of OFDM using SDR
11. Implementation of Cognitive radio using SDR

Audio Video Engineering

List of Experiments (Minimum 8 experiments are to be performed).

1. Voltage and waveform analysis for color TV.
2. Study of direct to home TV and set top box.
3. Study Wi-Fi TV system
4. Study of Digital TV pattern generator.
5. Study of HDTV
6. Study of Digital TV.
7. Simulation of Video, Audio and Image compressing techniques (Software Assignments)
8. Study of Audio system: CD players and MP3 player.
9. Study of PA system with chord less microphone
10. Directivity pattern of Microphones / Loud speakers
11. Visit to TV transmitter/ Digital TV Studio/ All India Radio / TV Manufacturing factory

*Any one subject from the list of Elective IV of computer/IT/Electrical/Instrumentation or Institute can offer elective IV based on any industry need with prior approval from BoS(Electronics). Repetition of subjects or topics is to be avoided.

Project Phase-II (404195)

Teaching Scheme:		Examination Scheme:
Tutorial: 6Hrs/week		TW:100 Marks OR: 50 Marks

1. Group Size

The student will carry the project work individually or by a group of students. Optimum group size is in 3 students. However, if project complexity demands a maximum group size of 4 students, the committee should be convinced about such complexity and scope of the work.

2. Selection and approval of topic

Topic should be related to real life application in the field of Electronics and Telecommunication

OR

Investigation of the latest development in a specific field of Electronics or Communication or Signal Processing

OR

The investigation of practical problem in manufacture and / or testing of electronics or communication equipment

OR

The Microprocessor / Microcontroller based applications project is preferable.

OR

Software development project related to VHDL, Communication, Instrumentation, Signal Processing and Agriculture Engineering with the justification for techniques used / implemented is accepted.

OR

Interdisciplinary projects should be encouraged. The examination will be conducted independently in respective departments.

3. Note:

The group should maintain a logbook of activities. It should have entries related to the work done,problems faced, solution evolved etc., duly signed by internal and external guides.

Project report must be submitted in the prescribed format only. No variation in the format will be accepted. One guide will be assigned at the most 3 project groups.

Audit Course-VI
Team Building, Leadership and Fitness for Engineers

Credits: 00				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

About the course

Team building allows students to work together in social situations just as they would in the classroom, their daily lives, or down the road in the workplace. Team building challenges students to solve problems and execute working with others. It shows them how to be accountable. It allows team members to stay motivated and energized to work on the project together. They work on jobs and tasks cohesively, rather than working alone without interaction. By working together, members of the team can "work together, stay together, and achieve together" .Trust and communication issues can also be noticed from team building exercises. Team building is known to improve performance in teams; members will remain motivated and can easily overcome indifferences to see the strengths in all team members.

Leadership is about the art of motivating, influencing and directing people so that they work together to achieve the goals of a team or broader organization. It's important for students to experience leadership opportunities during their schooling, to learn the art of building relationships within teams, defining identities and achieving tasks effectively. It also provides an opportunity to learn to identify and display effective communication and interpersonal skills. Leadership begins with identifying and understanding our values. Our values are our fundamental beliefs – those principles we consider to be worthwhile and desirable. Fitness does not only refer to being physically fit, but also refers to a person's mental state as well. If a person is physically fit, but mentally unwell or troubled, he or she will not be able to function optimally. Mental fitness can only be achieved if your body is functioning well. You can help relax your own mind and eliminate stresses by exercising regularly and eating right. People who are physically fit are also healthier, are able to maintain their most optimum weight and are least prone to cardiac and other health problems. In order to maintain a relaxed state of mind, a person should be physically active. A person who is fit both physically and mentally strong enough to face the ups and downs of life, and is not affected by drastic changes if they take place.

Course Objectives:

- To develop understanding of team skills and dynamics
- To identify and develop personal skills to become a more effective team member
- To introduce to the students the social change model of leadership
- To expose students to the leadership skills and imbibe within them that the fact that

- Leadership is a process, not a characteristic associated with an individual or role.
- To enable student to understand principles of fitness training and exercise
- To enable students to understand human posture, nutritional values and mental fitness

Course Outcomes:

On completion of the course, society will observe –

1. Change in awareness levels, knowledge and understanding of today's youth
2. Change in attitudes / behavior of students with regards to their improved teamwork,

3. institutional leadership and other life skills
4. Increase in the body's fitness levels and also reduced health problems
5. Improvement in social health and attitude.

Unit 1: Team Building

Types of Teams, Characteristics of a Team, Stages of Team Development (Forming ,Storming, Norming, Adjourning) , Systematic Approach to Team Work , High Performing Team (Characteristics , Maintenance , Causes of low performance Why Teams Fail , People,Communication , Resources , Objectives)

Unit II: Leadership

Defining Leadership , Personal Leadership Profile, Leadership in the Context of Community, Leadership Theory, Leadership Concepts, Foundations of Group Behavior: The Meaning of Group, Group behavior & Group Dynamics, Types of Groups, The Five -Stage Model of Group Development Managing Organizational Change, Leadership Styles leading to Authenticity, Learning and Development, Positive Responses to Aggressive Behavior, Professionalism, Team Building

Unit III: Educational Leadership

Key challenges for educational leaders, Characteristics, Capabilities of authentic leader, values and ethics in decision making, Continuous professional Development suitable for 21st century pedagogy, Emotional intelligence for educational leaders. Need of Educational research for educational leadership

Unit IV: Fitness for Engineers

Fundamentals of Exercise Science: Skeletal, muscular, cardiovascular, nervous system, nutrition, flexibility, special population and injuries, Basics of fitness, Weight management and supplementation

Guidelines for Conduction (Any one or more of following but not limited to)
• Guest Lectures
• Group Activities
• Assignment
• Taking up assisted Health challenge for short duration (ex. Yoga and Pranayam, Weight management , stability in mental health)

Guidelines for Assessment (Any one or more of following but not limited to)
• Practical Test
• Presentation
• Paper / (Theory assessment test)
•• Report

Sources/ References:

1. Organizational Behavior by Fred Luthans
2. Organizational Behavior by M N Mishra
3. Leadership Development Activities, John Adair, 2nd Edition Jaico Publication
4. Leadership Games, Stephen S Kogan,
5. Mastering Leadership, 2nd Edition, Michael Williams, Viva Books
6. Sculpt and Shape: The Pilates Way by Yasmin Karachiwala
7. Total Fitness: The Leena Mogre Way by Leena Mogre
8. Don't Lose Your Mind, Lose Your Weight: Rutuja Diwekar
9. Yog Its Philosophy and Practice English by Swami Ramdev ji

Audit Course-VI

ENVIRONMENTAL ISSUES AND DISATER MANAGEMENT

Credits: 00				
Teaching Scheme:			**Examination Scheme:**	
Lecture : 03 hr/week				**In-Sem : 30 Marks** **End-Sem: 70 Marks**

About the Course:

The importance of environmental science and environmental studies cannot be disputed. The need for sustainable development is a key to the future of mankind. Continuing problems of pollution, loss of forget, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer and loss of biodiversity have made everyone aware of environmental issues.

It is clear that no citizen of the earth can afford to be ignorant of environment issues. Environmental management has captured the attention of health care managers. Managing environmental hazards has become very important. In spite of the deteriorating status of the environment, study of environment has so far not received adequate attention in our academic programmes.

Course objective :

- To develop understanding of Environment Issues and Biodiversity
- To introduce to the students the environment, Disaster Management
- To enable students to understand ecosystem and preservation of environment
- To understand Disaster Management and handling them

Course Outcomes :

On completion of course students will be able:

- To learn the different environmental issues and disasters.
- To deal with problems associated with environment and effectively handle the disasters.

Unit 1: Environmental Pollution

A) Definition, Cause, effects and control measures of :-

Air pollution,Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management, urban and industrial wastes.

Role of an individual in prevention of pollution. Pollution case studies.

B) Social Issues and the Environment:

Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns.

Unit 2 : Ecosystems, Biodiversity and its conservation

A) Concept of an ecosystem.

Structure and function of an ecosystem, Producers, consumers and decomposers, • Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids.

Structure and function of the following ecosystem :

a. Forest ecosystem

b. Grassland ecosystem

c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity at global, National and local levels, India as a mega-diversity nation

Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Unit 3 : Disaster Management a) Causes – Natural disaster and Manmade disaster b) Speed of onset – Sudden and Slow **Natural Disasters** These types of disaster naturally occur in proximity to, and pose a threat to, people, structures or economic assets. Examples are Storm, Flood, Earthquake, Tsunamis **Manmade Disasters** Accidents: Road, Rail, Air, Sea, Building collapse. Industrial Mishaps: Gas leak, Explosion, Safety. Fire: Building, Coal, Oil. Forest Fire (In tropical counters, forest fires are often manmade) Speed of onset 1 Sudden onset: little or no warning, minimal time to prepare. For example, an earthquake, tsunami, cyclone, volcano, etc. 2 Slow onset: adverse event slow to develop; first the situation develops; the second level is an emergency; the third level is a disaster. For example, drought, civil strife, etc.
Unit 4: Case Studies • Environmental ethics: Awareness, Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. • Wasteland reclamation. • Consumerism and waste products. • Environment Protection Act. • Air and Water (Prevention and Control of Pollution) Act • Wildlife Protection Act and Forest Conservation Act • Issues involved in enforcement of environmental legislation. • Role of an individual in prevention of pollution and case studies.
References: 1. Disaster Management: Disaster Manager's Handbook by W. Nick Carter, Asian Development Bank. 2. An Introduction To Disaster Management EBook By S. Vidyanathan - Publisher: IKON 3. Textbook for environmental studies , Erach Bharucha For UGC.

Savitribai Phule Pune University

Faculty of Science and Technology

Syllabus for Final Year of Mechanical Engineering

(Course 2015)

Savitribai Phule Pune University

B. E. (Mechanical) (2015 Course) Semester – I

Code	Subject	Teaching Scheme Hrs / week			Examination Scheme					Total Marks	Credits	
		Lecture	Tut	Pract	In Sem	End Sem	TW	PR	OR		Theory	TW/ Pr/OR
402041	Hydraulics and Pneumatics	3	-	2	30	70	25	-	25	150	3	1
402042	CAD CAM Automation	3	-	2	30	70	25	50	-	175	3	1
402043	Dynamics of Machinery	4	-	2	30	70	25	-	25	150	4	1
402044	Elective-I	3	-	2	30	70	25	-	-	125	3	1
402045	Elective-II	3	-	-	30	70	-	-	-	100	3	-
402046	Project-I	-	-	4	-	-	25	-	25	50	-	2
Total		16	-	12	150	350	125	50	75	750	16	6
											22	

B. E. (Mechanical) (2015 Course) Semester – II

Code	Subject	Teaching Scheme Hrs / week			Examination Scheme					Total Marks	Credits	
		Lecture	Tut	Pract	In Sem	End Sem	TW	PR	OR		Theory	TW/ Pr/OR
402047	Energy Engineering	3	-	2	30	70	25	-	25	150	3	1
402048	Mechanical System Design	4	-	2	30 (1.5 Hrs)	70 (3 Hrs)	25	-	50	175	4	1
402049	Elective-III	3	-	2	30	70	25	-	-	125	3	1
402050	Elective-IV	3	-	-	30	70	-	-	-	100	3	-
402051	Project-II	-	-	12	-	-	100	-	100	200	-	6
Total		13	-	18	120	280	175	-	175	750	13	9
											22	

Elective – I		Elective – II	
Code	Subject	Code	Subject
402044 A	Finite Element Analysis	402045 A	Automobile Engineering
402044 B	Computational Fluid Dynamics	402045 B	Operation Research
402044 C	Heating Ventilation and Air Conditioning	402045 C	Energy Audit and Management
		402045 D	Open Elective**

Elective – III		Elective – IV	
402049 A	Tribology	402050 A	Advanced Manufacturing Processes
402049 B	Industrial Engineering	402050 B	Solar & Wind Energy
402049 C	Robotics	402050 C	Product Design and Development
		402050 D	Open Elective**

: Open Elective – Board of studies (BoS) – Mechanical and Automobile Engineering will declare the list of subjects, which can be taken under open electives or any other Electives that are being taught in the current semester, to the same level, as Elective – II and Elective -IV under engineering faculty in the individual college and Industry can define new elective subject with proper syllabus using defined framework of Elective II and Elective IV and ***get it approved from board of studies and other necessary statutory systems in the Savitribai Phule Pune University, Pune, before 30th November* of previous academic year in which the subject to be introduced . Without prior approval from University statutory system, no one can introduce the open elective in curriculum.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402041 **Course Name : Hydraulics and Pneumatics**

Teaching Scheme:		**Credits**		**Examination Scheme:**			
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR**	**: --**
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR**	**: 25**
						TW	**: 25**

Pre-requisites	: Fluid Mechanics, Manufacturing Processes and Machines, Mechatronics

Course Objectives:

- To study governing laws used in fluid power systems
- To study fluid power applications
- To study working principles of various components
- To study selection of different components
- To study how to design fluid power systems
- To study low cost automation

Course Outcomes:

On completion of the course, students will be able to -

- Understand working principle of components used in hydraulic & pneumatic systems
- Identify various applications of hydraulic & pneumatic systems
- Selection of appropriate components required for hydraulic and pneumatic systems
- Analyse hydraulic and pneumatic systems for industrial/mobile applications
- Design a system according to the requirements
- Develop and apply knowledge to various applications

Course Contents

Unit 1: Basics of Fluid Power and Pumps **6 Hrs**

Fluid power basics, advantages and limitations, fluid power distribution, standard symbols, energy loss in hydraulic systems.

Pumps - types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, and characteristics curves.

Unit 2: Actuators and Power Unit **6 Hrs**

Linear and rotary actuators- types, construction and characteristics. Cylinder mountings, cushioning of cylinders.

Power units and accessories - types of power units, reservoir assembly, constructional details. Accumulators, Intensifiers, Pressure and Temperature switches /sensors, level sensors.

Unit 3: Fluid Power Control **6 Hrs**

Direction control valves - center positions, methods of actuation, two stage valves, Flow control valves - pressure and temperature compensated. Pressure control valves - pressure reducing valve, sequence valve, unloading valve, brake valve, back pressure valve, counter balance valve, check valves, prefill valve, servo valves, cartridge valves, proportional valves.

Unit 4: Hydraulic Circuits and Contamination Control **6 Hrs**

Hydraulic circuits: Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, unloading circuit, motor breaking circuit etc.

Contamination control: Contamination, sources of contamination, suction strainer, filters, filtration, filter ratings.

Unit 5: Pneumatics – Components, Control Valves and Circuits **6 Hrs**

Compressors - Types, principle of working and constructional details. Comparison of pneumatic with hydraulic power transmissions. Types of filters, pressure regulators, lubricators, mufflers, dryers, direction control valves, pneumatic actuators, shuttle valve, two pressure valve, quick exhaust valve and time delay valves, electro-pneumatics. Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc. Application of pneumatics in low cost automation and in industrial automation.

Unit 6: System Analysis and Design **6 Hrs**

Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads, design considerations for cylinders, Design of hydraulic/pneumatic circuits for practical application, selection of different components such as reservoir, control elements, actuators, accumulator, intensifier, filters, pumps. (Students are advised to refer manufacturers' catalogues for design and use simulation tool like Automation Studio for analysis).

Books

Text :

1. Esposito A, Fluid Power with application, Prentice Hall
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
4. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

References :

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Yeaple, Fluid Power Design Handbook
4. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer's Catalogues

Term Work shall consist of following experiments and assignments:

1. Test on Gear/Vane/Piston pump and plotting performance characteristics
2. Following experiments to be done on hydraulic trainer (any 3)
   a) Regenerative circuit
   b) Speed control circuit
   c) Sequencing circuit
   d) Traverse and feed circuit etc.
3. Following experiments to be done on pneumatic trainer (any 3)

a) Automatic reciprocating circuit
b) Speed control circuit
c) Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve
d) Electro pneumatic circuits

4. Test on pressure relief valve/flow control valve
5. Test on linear /rotary actuator
6. Design of simple hydraulic systems used in practice using manufacturers' catalogue and analysis using software such as Automation Studio.
7. Design of simple pneumatic systems used in practice using manufacturers' catalogue and analysis using software such as Automation Studio.
8. Industrial visit to study Hydraulic / Pneumatic based Automation systems
9. Assignment: Symbols for different components as per standards
10. Assignment: Trouble shooting procedures
11. Assignment: Standard specifications of hydraulic/ pneumatic components using manufacturer's catalogues.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402042 **Course Name : CAD CAM and Automation**

Teaching Scheme:		Credits		Examination Scheme:			
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR : 50**	
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR : --**	
						TW : 25	

Pre-requisites	**:**	Engineering Graphics, Engineering Mathematics, Numerical Methods & Optimization, Computer Aided Machine Drawing, Strength of Materials, Manufacturing Processes

Course Objectives:

- To apply homogeneous transformation matrix for geometrical transformations of 2D/3D CAD entities
- To model mathematically analytical and synthetic curves, surfaces
- To predict performance of simple mechanical components viz. beam, shafts, plates, trusses using FEA (Mathematical and Software treatment)
- To generate CNC program for appropriate manufacturing techniques viz. turning and milling
- To select and apply suitable Rapid Prototyping techniques for engineering applications
- To study role and components of different Automation strategies.

Course Outcomes:

On completion of the course, students will be able to -

- Apply homogeneous transformation matrix for geometrical transformations of 2D CAD entities for basic geometric transformations.
- Use analytical and synthetic curves and surfaces in part modeling.
- Do real times analysis of simple mechanical elements like beams, trusses, etc. and comment on safety of engineering components using analysis software.
- Generate CNC program for Turning / Milling and generate tool path using CAM software.
- Demonstrate understanding of various rapid manufacturing techniques and develop competency in designing and developing products using rapid manufacturing technology.
- Understand the robot systems and their applications in manufacturing industries.

Course Contents

Unit 1: Computer Graphics **6 Hrs**

Transformations (2D & 3D) : Introduction, Formulation, Translation, Shear, Rotation, Scaling and reflection, Homogeneous representation, Concatenated transformation, Mapping of geometric models, Inverse transformations, Introduction to 3D transformation (Theory + Numerical treatment only for 2D – Max 3 vertices)

Projections : Orthographic, Isometric, Perspective projections (Only theory)

Unit 2: Geometric Modeling **6 Hrs**

Curves – Introduction, Analytical curves (Line, circle, ellipse, parabola, hyperbola), Synthetic curves (Hermite Cubic Spline, Bezier, B-Spline Curve) [Numerical on Line, Circle, Ellipse, Hermite Cubic

Spline, Bezier]
Surfaces – Introduction, Surface representation, Analytic surfaces, Synthetic Surfaces, Hermite bicubic, Bezier, B-Spline, Coons patch surface, Applications in freeform surfaces [only Theory]
Solids - Introduction, Geometry and Topology, Solid Representation, Boundary Representation, Euler's equation, Constructive Solid Geometry (CSG), Boolean operation for CSG [only Theory]

Unit 3: Finite Element Analysis (FEA) **6 Hrs**

Introduction : Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads and constraints), General FEM procedure, Applications of FEM in various fields, meshing, p and h formulation, Advantages and disadvantages of FEM [Only theory]
One Dimensional Problem: Finite element modeling, coordinate and linear shape function, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, Temperature Effects. [Theory + Numerical – composite shaft, spring elements in series and parallel]
Trusses : Introduction, 2D Trusses, Assembly of Global Stiffness Matrix [Numerical limited to 4X4 matrix]

Unit 4: Computer Aided Manufacturing (CAM) **6 Hrs**

Introduction to Computer Aided Manufacturing (CAM), Coordinate system, Working principal of CNC Lathe, Turning Centers, Milling Machine, Steps in developing CNC part program, Tool and geometric compensations, subroutine and Do loop using canned cycle. [Only theory – 2 hrs]
CNC Lathe part programming (FANUC) : Linear and circular interpolation, Canned cycles for facing, threading, grooving, etc. [Theory + Program]
*CNC Milling part programming (FANUC)***:** Linear and circular interpolation, Pocketing, contouring and drilling cycles. [Theory + Program]

Unit 5: Advanced Manufacturing Method **6 Hrs**

Product Life Cycle: Introduction, Need, Components/Elements of PLM, Collaborative Engineering. [Only theory]
Rapid Prototyping : Introduction, classification of RP Processes (SLA, LOM, SLS, FDM, 3D printing), Working principle, features, models & specification of process, application, advantages and disadvantages, Rapid Tooling and STL format, Concept of 4D Rapid Prototyping. [Only theory]

Unit 6: Automation **6 Hrs**

Automation : Introduction, Automation strategies, Types of Automation - Hard and Soft Automation, Flexible Manufacturing System – Types, Advantages, Limitations, AGVs and AS/RS [Only theory]
*Group Technology***:** Introduction, Coding Methods, Concepts of Computer Integrated Manufacturing (CIM) and Computer Aided Process Planning (CAPP), Variant & Generative methods of CAPP, advantages of CAPP. [Only theory]
Robotics: RIA definition of Robot, Laws of robotics, Classification of robots, robot anatomy, Point to point and continuous path robotic systems, Joints, End Effectors, Grippers - Mechanical, Magnetic and Pneumatic, Applications. [Only theory]

Books

Text :

1. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill Publishing Co. 2009

2. Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering - Prentice Hall India.
3. Nitin S. Gokhale, Practical Finite Element Analysis, Finite To Infinite; First Edition edition, ISBN-10: 8190619500 ISBN-13: 978-8190619509
4. S. K. Sinha, CNC Programming using Fanuc Custom Macro B, McGraw-Hill Professional
5. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.

References :

1. Ibraim Zeid, Mastering CAD/CAM – Tata McGraw Hill Publishing Co. 2000
2. Segerling L. J. - Applied Finite Elements Analysis, John Wiley and Sons
3. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
4. Rao P. N., Introduction to CAD/CAM Tata McGraw Hill Publishing Co.
5. B. S. Pabla, M. Adithan, CNC Machines, New Age International, 1994
6. Groover M.P.-Automation, production systems and computer integrated manufacturing‘ - Prentice Hall of India
7. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer
8. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, Product Design for Manufacture and Assembly, Third Edition ,CRC Press
9. Antti Saaksvuori, Anselmi Immonen, Product Life Cycle Management -Springer, 1st Edition, 2003

Term Work shall consist of following experiments and assignments:

1. Demonstration of Application Programming Interface (API).
2. Stress and deflection analysis of Beam (FEA).
3. Stress and deflection analysis of 2D truss (FEA).
4. Stress and deflection analysis of any Mechanical Component using FEA software and validate the results by analytical methods (FEA).
5. Tool path generation and simulation for Turning – Grooving and Threading with help of suitable software.
6. Tool path generation and simulation for Milling – Facing, Pocketing, Contouring and drilling, etc. with help of suitable software.
7. Case study on Rapid Prototyping - Exporting STL files from 3D CAD models, structure of STL files, etc.
8. Case study based on modeling and analysis of structural system (Industry Based)
9. Manufacturing of machine component using additive manufacturing or Using CNC simulator software.
10. Assignment on Robot simulation
11. Industrial Visit Report on Automation and Robotics

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402043 **Course Name : Dynamics of Machinery**

Teaching Scheme:		**Credits**		**Examination Scheme:**		
Theory	**: 04 Hrs Per Week**	**TH**	**: 04**	**Theory**	**In-Sem : 30**	**PR : --**
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR : 25**
						TW : 25

Pre-requisites: Strength of Materials, Engineering Mechanics, Engineering Mathematics and Numerical Methods,

Course Objectives:

- To conversant with balancing problems of machines.
- To understand fundamentals of free and forced vibrations.
- To develop competency in understanding of vibration and noise in Industry.
- To develop analytical competency in solving vibration problems.
- To understand the various techniques of measurement and control of vibration and noise.

Course Outcomes:

On completion of the course, students will be able to -

- Apply balancing technique for static and dynamic balancing of multi cylinder inline and radial engines.
- Estimate natural frequency for single DOF undamped & damped free vibratory systems.
- Determine response to forced vibrations due to harmonic excitation, base excitation and excitation due to unbalance forces.
- Estimate natural frequencies, mode shapes for 2 DOF undamped free longitudinal and torsional vibratory systems.
- Describe vibration measuring instruments for industrial / real life applications along with suitable method for vibration control.
- Explain noise, its measurement & noise reduction techniques for industry and day today life problems.

Course Contents

UNIT 1: Single Degree of Freedom Systems – Free Vibration **10 Hrs**

Fundamentals of Vibration : Elements of a vibratory system, vector representation of S.H.M., degrees of freedom, Introduction to Physical and Mathematical modeling of vibratory systems : Bicycle, Motor bike and Quarter Car. types of vibration, equivalent stiffness and damping, formulation of differential equation of motion (Newton, D’Alembert and energy method)

Undamped free vibrations: Natural frequency for longitudinal, transverse and torsional vibratory systems.

Damped free vibrations: Different types of damping, Viscous damping – over damped, critically damped and under damped systems, initial conditions, logarithmic decrement, Dry friction or coulomb damping - frequency and rate of decay of oscillations.

UNIT 2: Single Degree of Freedom Systems - Forced Vibrations **8 Hrs**

Forced vibrations of longitudinal and torsional systems, Frequency Response to harmonic excitation, excitation due to rotating and reciprocating unbalance, base excitation, magnification factor, Force and Motion transmissibility, Quality Factor. Half power bandwidth method, Critical speed of shaft having single rotor of undamped systems.

UNIT 3: Two Degree of Freedom Systems – Undamped Vibrations **8 Hrs**

Free vibration of spring coupled systems – longitudinal and torsional, torsionally equivalent shafts, natural frequency and mode shapes, Eigen value and Eigen vector by Matrix method, Combined rectilinear and angular motion, Vibrations of Geared systems.

UNIT 4: Balancing **8 Hrs**

Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multi-cylinder in-line engines, direct and reverse cranks method -radial and V engines.

UNIT 5: Measurement and Control of Vibration **8 Hrs**

A) Measurement: Vibration Measuring Instruments, Accelerometers, Impact hammer, Vibration shakers, Vibration Analyzer, Vibration based condition monitoring, Analysis of Vibration Spectrum, Standards related to measurement of vibration, Human response to vibrations.

B) Control : Vibration control methods, passive, semi active (Introduction to Electro-Rheological & Magneto-Rheological dampers) and active vibration control, control of excitation at the source, control of natural frequency, Vibration isolators, Tuned Dynamic Vibration Absorbers, Introduction to Torsional Damper

UNIT 6: Introduction to Noise **6 Hrs**

Fundamentals of noise Sound concepts, Decibel Level, white noise, weighted sound pressure level, Logarithmic addition, subtraction and averaging, sound intensity, noise measurement, sound fields, octave band, sound reflection, absorption and transmission, acoustic material & its characteristics, Noise control at the Source, along the path and at the receiver, pass-by-noise, Reverberation chamber, Anechoic Chamber, Human Exposure to Noise and Noise standards.

Books

Text :

1. S. S. Rao, Mechanical Vibrations, Pearson Education Inc. New Delhi.
2. G. K. Grover, Mechanical Vibrations, New Chand and Bros.,Roorkee
3. Wiiliam J Palm III, Mechanical Vibration, Wiley India Pvt. Ltd, New Delhi
4. Uicker J. John, Jr, Pennock Gordon R, Shigley Joseph E., Theory of Machines and Mechanisms, International Version, OXFORD University Press, New Delhi.
5. M L Munjal, Noise and Vibration Control, Cambridge University Press India

References :

1. Weaver, Vibration Problems in Engineering, 5th Edition Wiley India Pvt. Ltd, New Delhi.
2. Bell, L. H. and Bell, D. H., Industrial Noise Control – Fundamentals and Applications‖, Marcel Dekker Inc.
3. Alok Sinha, Vibration of Mechanical System, Cambridge university Press , India
4. Debabrata Nag, Mechanical Vibrations, Wiley India Pvt. Ltd, New Delhi.
5. Kelly S. G., Mechanical Vibrations, Schaums outlines, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

6. Meirovitch, L., Elements of Mechanical Vibrations‖, McGraw Hill.
7. Ver, Noise and Vibration Control Engineering, Wiley India Pvt. Ltd, New Delhi.
8. Bies, D. and Hansen, C., Engineering Noise Control - Theory and Practice, Taylor and Francis.
9. Shrikant Bhave, Mechanical Vibrations Theory and Practice, Pearson, New Delhi

Term Work shall consist of following experiments and assignments:

A] Compulsory Experiments (Sr. No. 1 to 6)

1. Balancing of wheel / rotor on computerized balancing machine OR Experimental verification of dynamic balancing of rotating masses.
2. To determine the natural frequency of damped vibration of single degree freedom system and to find it‘s damping coefficient.
3. To obtain frequency response curves of single degree freedom system of vibration for different amount of damping.
4. To verify natural frequency of torsional vibration of two rotor system and position of node.
5. To determine natural frequency of transverse vibration of beam using vibration analyzer.
6. Noise measurement and analysis using vibration Analyzer.

B] Any Two Experiments from the following :

1. To determine critical speed of shaft with single rotor.
2. Experimental verification of principle of dynamic vibration absorber.
3. Experiment on shock absorbers and to plot its characteristic curve.
4. A case study (Industrial visit / In-house) based on Conditioning Monitoring and Fault Diagnosis.

C] List of Compulsory Assignment :

1. Simulation (using suitable software) of free response of SDOF damped system to demonstrate different damping conditions by solving differential equation numerically.

OR

2. Simulation (using suitable software) of total response of SDOF damped system to harmonic excitation by solving differential equation numerically.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402044 A **Course Name : Elective – I Finite Element Analysis**

Teaching Scheme:		**Credits**		**Examination Scheme:**		
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR : --**
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR : --**
						TW : 25

Pre-requisites	**:** Fluid Mechanics, Heat transfer, Numerical methods, Programming Languages.

Course Objectives:

- To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics and thermal analysis problems.
- To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
- It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states.
- To study approximate nature of the finite element method and convergence of results are examined.
- It provides some experience with a commercial FEM code and some practical modeling exercises .

Course Outcomes:

On completion of the course, students will be able to -

- Understand the different techniques used to solve mechanical engineering problems.
- Derive and use 1-D and 2-D element stiffness matrices and load vectors from various methods to solve for displacements and stresses.
- Apply mechanics of materials and machine design topics to provide preliminary results used for testing the reasonableness of finite element results.
- Explain the inner workings of a finite element code for linear stress, displacement, temperature and modal analysis.
- Use commercial finite element analysis software to solve complex problems in solid mechanics and heat transfer.
- Interpret the results of finite element analyses and make an assessment of the results in terms of modeling (physics assumptions) errors, discretization (mesh density and refinement toward convergence) errors, and numerical (round-off) errors.

Course Contents

Unit 1: Fundamental Concepts of FEA **6 Hrs**

Introduction: Solution methodologies to solve engineering problems, governing equations, mathematical modelling of field problems in engineering, discrete and continuous models.

Brief history of FEM, Finite Element terminology (nodes, elements, domain, continuum, degrees of freedom, loads & constraints), general steps involved in FEM, applications of FEM in various fields, advantages and disadvantages of FEM, consistent units system, essential and natural boundary conditions, symmetric boundary conditions.

Introduction to different approaches used in FEA : Direct approach, Variational formulation-Principal of Minimum Potential Energy (PMPE), Galerkin weighted residual method, Principle of Virtual Work, Rayleigh-Ritz method, relation between FEM and Rayleigh-Ritz method

Types of Analysis (Introduction) : Linear static analysis, Non-linear analysis, Dynamic analysis, Linear buckling analysis, Thermal analysis, Fatigue analysis, Crash analysis.

Unit 2: 1D Elements **6 Hrs**

Types of 1D elements, displacement function, global and local coordinate systems, polynomial form of interpolation functions- linear, quadratic and cubic, properties of shape function, primary and secondary variables.

Formulation of elemental stiffness matrix and load vector for bar, truss and beam using any approach, Formulation of load vector due to uniform temperature change (only for bar).

Assembly of global stiffness matrix and load vector, properties of stiffness matrix, half bandwidth, treatment of boundary conditions- elimination approach, stress and reaction forces calculations

Unit 3: 2D Elements **6 Hrs**

Two-Dimensional Stress Analysis: Plane Stress/Strain problems in 2D elasticity, constitutive relations

Constant Strain Triangle(CST), Liner Strain Rectangle (LSR), displacement function, Pascal's triangle, compatibility and completeness requirement, geometric isotropy, convergence requirements, strain filed, stress filed, Formulation of element stiffness matrix and load vector for Plane Stress/Strain problems

Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), stress calculations

Unit 4: Isoparametric Elements and Numerical Integration **6 Hrs**

Concept of isoparametric elements, Terms isoparametric, super parametric and subparametric.

Coordinate mapping : Natural coordinates, Area coordinates (for triangular elements), higher order triangular and quadrilateral elements (Lagrangean and serendipity elements), geometry associative mesh, quality checks, mesh refinement- p vs h refinements, Uniqueness of mapping - Jacobian matrix.

Numerical integration: Gauss Quadrature in one and two dimension, Order of Gauss integration, full and reduced integration, sub-modeling, substructuring.

Unit 5: 1D Steady State Heat Transfer Problems **6 Hrs**

Introduction, One dimensional steady-state heat transfer problem- Governing differential equation, Finite Element formulation using Galerkin's approach for composite wall and thin Fin , essential and natural boundary conditions and solving for temperature distribution

Unit 6: Dynamic Analysis **6 Hrs**

Types of dynamic analysis, general dynamic equation of motion, lumped and consistent mass, Mass matrices formulation of bar, truss and beam element.

Undamped-free vibration: Eigenvalue problem, evaluation of eigenvalues and eigenvectors (characteristic polynomial technique).

Books

Text :

1. Daryl L, A First Course in the Finite Element Method,. Logan, 2007.
2. G Lakshmi Narasaiah, Finite Element Analysis, B S Publications, 2008.
3. Y.M.Desai, T.I.Eldho and A.H.Shah, Finite Element Method with Applications in Engineering, Pearson Education, 2011
4. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002.
5. P., Seshu, Text book of Finite Element Analysis, PHI Learning Private Ltd. , New Delhi, 2010.

References :

1. Bathe K. J., Finite Element Procedures Prentice, Hall of India (P) Ltd., New Delhi.
2. R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India
3. Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press, 1997
4. Peter Kattan, MATLAB Guides to Finite Elements- An Interactive Approach, Springer, 2008.
5. S. Moaveni, Finite element analysis, theory and application with Ansys, Prentice Hall
6. Erdogan Madenci and Ibrahim Guven, “The Finite Element Method and Applications in Engineering Using Ansys”, Springer, 2006.
7. David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill
8. Gokhale N. S., et al., Practical Finite Element Analysis, Finite to Infinite, Pune, 2008.

Term Work shall consist of following assignments:

Practical’s to be performed: Minimum 7 including

- Any three practical’s *from Practical No. 1 to 4** and
- Any three practical *from Practical No. 5 to 9***
- in Open source or Commercial Software

1. Computer program for stress analysis of 1D bar using linear and quadratic elements. Show the variation of stress and strain within the element for linear and quadratic bar element
2. Computer program for stress analysis of 2-D truss subjected to plane forces
3. Computer programs for (i) modal analysis and, (ii) stress analysis for 1-D beam (simply supported or cantilever beams)
4. Computer program for 1-D temperature analysis
5. Static stress concentration factor calculation for a plate with center hole subjected to axial loading in tension using FEA software
6. Modal analysis of any machine component using FEA software.
7. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
8. Elasto-plastic stress analysis of plate using FEA software
9. Coupled Thermal-Structural Analysis using FEA software

*1 Students can write the program in any of the programming language such as FORTRAN, C, C++, MATLAB, Python, VB.

*2 Minimum number of elements considered should be 10 or more.

*3 Validate results of the program with analytical method or commercial FEA software such as Abaqus, ANSYS, Msc-Nastran, Optistruct / Radioss, Comsol-Multiphysics, etc.

**1 Students should do convergence study for all assignment problems.
**2 Use different element types from element library,
**3 If possible use submodel / symmetry option.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402044 B **Course Name : Elective – I Computational Fluid Dynamics**

Teaching Scheme:		Credits		Examination Scheme:			
Theory	: 03 Hrs Per Week	TH	: 03	Theory	In-Sem : 30	PR	: --
Practical	: 02 hrs per week	TW	: 01		End-Sem : 70	OR	: --
						TW	: 25

Pre-requisites	**:** Fluid Mechanics, Heat transfer, Numerical methods, Programming Languages.

Course Objectives:

- Students should be able to model fluid / heat transfer problems and apply fundamental conservation principles.
- Students should be able to do discretize the governing equations by Finite Difference Method and Finite volume Method.
- Students should be able to develop programming skills by in-house code development for conduction, convection and fluid dynamics problems.
- Students should be able to solve basic convection and diffusion equations and understands the role in fluid flow and heat transfer.
- To prepare the students for research leading to higher studies.
- To prepare the students for career in CAE industry using software tools.

Course Outcomes:

On completion of the course, students will be able to -

- Analyze and model fluid flow and heat transfer problems.
- Generate high quality grids and interpret the correctness of numerical results with physics.
- Conceptualize the programming skills.
- Use a CFD tool effectively for practical problems and research.

Course Contents

Unit 1: Introduction to CFD **6 Hrs**

Introduction to Computational Fluid Dynamics, Derivation and physical interpretation of governing equations (conservation of mass, momentum and energy) in differential form, Concept of substantial derivative, divergence and curl of velocity, Mathematical behavior of Governing Equations and boundary conditions.

Unit 2: Solution to Conduction Equation **6 Hrs**

Introduction to FEA, FDM and FVM, Solution of two dimensional steady and unsteady heat conduction equation using finite volume method (Implicit and Explicit) with Dirichlet, Neumann, Robbin boundary conditions, Stability Criteria.

Unit 3: Solution to Advection Equation **6 Hrs**

Solution of two dimensional steady and unsteady heat advection equation using finite volume method (Implicit and Explicit) with Dirichlet BC, Stability Criteria, Introduction to first order upwind, CD, second order upwind and QUICK convection schemes.

Unit 4: Solution to Convection-Diffusion Equation **6 Hrs**

Solution of two dimensional steady and unsteady heat convection-diffusion equation for slug flow using finite volume method (Implicit and Explicit), Stability Criteria, 1-D transient convection-diffusion system, Peclet Number

Unit 5: Solution to Navier – Stokes Equation **6 Hrs**

Solution of Navier-Stoke‘s equation for incompressible flow using SIMPLE algorithms for lid driven cavity flow problem, Introduction to external flow simulation.

Unit 6: Introduction to Turbulence Modeling **6 Hrs**

Introduction to turbulence models, Reynolds Averaged Navier-Stokes equations (RANS), One equation model (Derivation) and two equation model.

Books

Text :

1. John D Anderson: Computational Fluid Dynamics- The Basics with Applications, McGraw-Hill
2. Atul Sharma, Introduction to Computational Fluid Dynamics: Development, Application and Analysis, Wiley
3. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation
4. A. W. Date, Introduction to Computational Fluid Dynamics, Cambridge Univ. Press, USA.
5. H. Versteeg, and W.Malalasekara, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson.
6. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
7. J. Tu, G.-H. Yeoh and C. Liu: Computational Fluid Dynamics: A practical approach, Elsevier.
8. H. Schlichting and K. Gersten, Boundary-Layer Theory, Springer.

References :

1. H. Tennekes and J. L. Lumley, A First Course in Turbulence, MIT Press.
2. David C. Wilcox, Turbulence Modeling for CFD, DCW Industries

Term Work shall consist of following assignments:

Practical’s to be performed: Minimum 7 including

- Any three practical’s with programming language (*from Practical No. 1 to 8*) and
- Any three practical in Open source or Commercial Software (*from Practical No. 9 to 16*)
- Mini project (*Practical No.16*) in Open source or Commercial Software tool

1. One-dimensional steady state conduction using finite volume method
2. One-dimensional unsteady state conduction using finite volume method
3. Two-dimensional steady state conduction using finite volume method
4. Two-dimensional unsteady state conduction using finite volume method
5. Two-dimensional advection using finite volume method
6. One-dimensional conduction convection problem using finite volume method
7. One-dimensional conduction convection problem using finite volume method
8. Solution of Navier Stokes equation using SIMPLE algorithm for Lid Driven Cavity flow

problem

9. Numerical simulation and analysis of boundary layer over a flat plate (Blausius Equation)
10. Numerical simulation and analysis of boundary layer for a
11. Developing flow through Pipe
12. Fully developed flow through a pipe
13. CFD Analysis of external flow: Circular Cylinder or Airfoil (NACA 0012)
14. CFD analysis of heat transfer in pin fin.
15. Numerical simulation and analysis of 2D square lid driven cavity. Effect of Reynolds number on the vorticity patterns.
16. Mini project on any practical application. Students should take a problem of their choice and verify the CFD solution with experimental data / research paper. (Mandatory)

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402044 C **Course Name : Elective – I**

Heating, Ventilation, Air Conditioning and Refrigeration Engineering

Teaching Scheme:		**Credits**		**Examination Scheme:**			
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR**	**: --**
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR**	**: --**
						TW	**: 25**

Pre-requisites:	Thermodynamics I and II, Refrigeration and Air Conditioning

Course Objectives:

- To understand the recent vapour compression cycle
- To provide the knowledge of analyze thermal design of refrigeration system components
- To understand practical aspects of vapour compression system
- To provide the knowledge of basic concepts of ventilation, infiltration and space distribution techniques
- To inculcate techniques of estimating building envelop load.
- To understand the working non-conventional air-conditioning systems.

Course Outcomes:

On completion of the course, students will be able to -

- Determine the performance parameters of trans-critical & ejector refrigeration systems
- Estimate thermal performance of compressor, evaporator, condenser and cooling tower.
- Describe refrigerant piping design, capacity & safety controls and balancing of vapour compressor system.
- Explain importance of indoor and outdoor design conditions, IAQ, ventilation and air distribution system.
- Estimate heat transmission through building walls using CLTD and decrement factor &time lag methods with energy-efficient and cost-effective measures for building envelope.
- Explain working of types of desiccant, evaporative, thermal storage, radiant cooling, clean room and heat pump air-conditioning systems.

Course Contents

Unit 1: Advanced Vapour Compression Cycles **4 Hrs**

Review of vapour compression cycle, Trans-critical cycle and their types retical treatment) Ejector refrigeration cycle and their types. Presentation of cycle on P-h and T-s chart.

Unit 2: Thermal Design of Refrigeration System Components **8 Hrs**

Compressor : Characteristic curves of reciprocating & Centrifugal compressors, sizing of reciprocating compressor

Evaporator : Standards & Codes, Performance analysis of Dx evaporator,

Condenser: Standards & Codes, air-cooled condenser, shell & tube condenser and evaporative condenser.

Expansion Devices : Standards & Codes, Operating Characteristics, Liquid Charge in the Sensing Bulb , Hunting of Thermostatic Expansion Valve

Cooling Tower: Types & design of cooling towers, cooling tower thermal performance, tower efficiency.

Unit 3: Practical Aspects of Vapour Compression System **6 Hrs**

Refrigerant Piping : Copper Tubing, Piping Design for Reciprocating Refrigeration Systems, Size of Copper Tube, Refrigeration Load, and Pressure Drop, Sizing Procedure, Suction Line, Discharge Line (Hot-Gas Line), Liquid Line

Capacity Controls : Capacity Controls of reciprocating, centrifugal and scroll compressors

Safety Controls: Low-Pressure and High-Pressure Controls. Low-Temperature Control, Frost Control, Oil Pressure Failure Control. Motor Overload Control.

Vapour compression system balance: Performance characteristics of the condensing unit & compressor-capillary tube.

Unit 4: Ventilation and Infiltration **6 Hrs**

Indoor Design Criteria and Thermal Comfort : Basic parameters, factors affecting thermal comforts, Comfort-Discomfort Diagrams, Indoor Temperature, Relative Humidity, and Air Velocity

Indoor Air Quality : Indoor Air Contaminants, Basic Strategies to Improve Indoor Air Quality,

Outdoor Design Conditions : Outdoor Air Requirements for Occupants, The Use of Outdoor Weather Data in Design, Outdoor Weather Characteristics and Their Influence

Ventilation for cooling : Natural ventilation, mechanical ventilation

Space air distribution: Design of air distribution systems, Types of air distribution devices: Airflow patterns inside conditioned space: Stratified mixing flow: Cold air distribution: Displacement flow: *Spot cooling / heating*: Selection of supply air outlets.

Unit 5: Heat Load Estimation in Building Structures **6 Hrs**

Solar radiation, Heat gain through fenestrations, Space load characteristics, cooling load and coil load calculations, Overall heat transmission coefficient, air spaces, sol-air temperature, Decrement factor & time lag method,, Cooling load Temperature Difference method (CLTD) or Equivalent Temperature Differential (ETD), detailed calculation procedure using CLTD method, Total heat balance.

Energy-efficient and cost-effective measures for building envelope**,** Concept of ECBC

Unit 6: Advanced Air-conditioning Systems **6 Hrs**

Desiccant-Based Air Conditioning Systems : Introduction, Sorbents & Desiccants, Dehumidification, Liquid Spray Tower, Solid Packed Tower, Rotary Desiccant Dehumidifiers, Hybrid Cycles, Solid Desiccant Air-Conditioning (Theoretical treatment)

Evaporative-Cooling Air Conditioning Systems, Thermal Storage Air Conditioning Systems, Clean-Room Air Conditioning Systems, Radiant cooling. (Theoretical treatment)

Heat Pump Systems: Heat Pump Cycle, different heats pump Circuits.

Books

Text :

1. Arora R.C., Refrigeration and Air Conditioning, PHI, India
2. Dossat Ray J., Principal of Refrigeration, Pearson, India
3. Arora C P, Refrigeration and Air Conditioning, Tata McGraw Hill

4. Manohar Prasad, Refrigeration and Air-conditioning, Wiley Eastern Limited, 1983

References :

1. Threlkeld J.L., Thermal Environmental Engineering, Prentice Hall Inc. New Delhi
2. ASHRAE Handbook (HVAC Equipments)
3. Stocker W.F. and Jones J.W., Refrigeration and Air-conditioning, McGraw Hill International editions 1982.
4. Roger Legg, Air conditioning systems: Design, Commissioning and maintenance
5. Shan Wang, Handbook of Refrigeration and Air Conditioning, McGrawHill Publications
6. Wilbert Stocker, Industrial Refrigeration, McGrawHill Publications
7. Keith Harold, Absorption chillers and Heat Pumps, McGrawHill publications
8. ASHRAE, Air Conditioning System Design Manual, IInd edition, ASHRAE.

Term Work shall consist of following assignments:

1. Performance Simulation of Central Air-conditioning plant using Newton Raphson Method.
2. Performance analysis of Counter flow or cross flow cooling tower
3. Building heat load simulation using suitable software (Trace 700, Energy plus etc.)
4. Design of cold storage with process layout.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402045 A | **Course Name : Elective – II Automobile Engineering**

Teaching Scheme:		**Credits**		**Examination Scheme:**					
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem**	**: 30**	**PR**	**: --**
Practical	**: --**	**TW**	**: --**		**End-Sem**	**: 70**	**OR**	**: --**
							TW	**: --**

Pre-requisites : I. C. Engines, Theory of Machines, Basics of Electrical and Electronics

Course Objectives:

- To make the student conversant with fundamentals of automobile systems.
- To develop competencies in performance analysis of vehicles.
- To make the student conversant with automobile safety, electrical system and vehicle maintenance.
- To understand the emerging trends of electric vehicles, hybrid electric vehicles and solar vehicles. .

Course Outcomes:

On completion of the course, students will be able to -

- To compare and select the proper automotive system for the vehicle.
- To analyse the performance of the vehicle.
- To diagnose the faults of automobile vehicles.
- To apply the knowledge of EVs, HEVs and solar vehicles

Course Contents

Unit 1: Introduction and Drive Train **6 Hrs**

Introduction: Current scenario in Indian auto/ancillary industries, vehicle specifications and classification.

Chassis and Frames: Types of chassis layout with reference to power plant locations and drive, various types of frames, constructional details.

Drive Train: Types of transmission system, necessity and selection of clutch, necessity of gear box and different types, fluid flywheel, torque convertor, continuous variable transmission, , overdrive, propeller shaft, final drive and differential.

Unit 2: Axles, Wheels and Tyres, Steering System **6 Hrs**

Axles: Purpose, requirement and types of front and rear axle, loads acting on rear axles.

Wheels and tyres: Wheel construction, alloy wheel, wheel balancing, type of tyres, tyre construction, tyre materials, factors affecting tyre life.

Steering system : Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristics, steering linkages and gearbox, power steering, collapsible steering, reversibility of steering, four wheel steering, wheel alignment.

Unit 3: Suspension and Brake System **6 Hrs** *<u>Suspension</u>* : Types of suspension linkages, types of suspension springs- leaf, coil, air springs, hydro gas, rubber suspension, interconnected suspension, self levelling suspension (active suspension), shock absorbers (hydraulic and air). *<u>Brake systems</u>*: Drum, disc, mechanical, hydraulic, air brakes, vacuum, power assisted brakes, hand brake, ABS, EBD.
Unit 4: Vehicle Performance and Safety **6 Hrs** *<u>Vehicle performance</u>*: Parameters, vehicle resistances, traction and tractive effort, power requirement for propulsion, road performance curves (numericals), stability of vehicles, vehicle testing on chassis dynamometer. *<u>Vehicle safety</u>*: Types of active and passive safety, vehicle interior and ergonomics, NVH in automobiles.
Unit 5: Electrical System and Vehicle Maintenance **6 Hrs** *<u>Batteries</u>* : Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods, introduction to lithium batteries. *<u>Electrical system and accessories</u>* : Insulated and earth return systems, positive and negative earth systems, electrical fuel pump, speedometer, fuel, oil and temperature gauges, horn, wiper system, automotive sensors and actuators, electronic control unit/module. *<u>Maintenance</u>*: Types of vehicle maintenance, servicing/overhauling of clutch, gear box, propeller shaft, differential, axles, steering system, suspension system, break system, electrical system.
Unit 6: Electric and Hybrid Electric Vehicles **6 Hrs** *<u>Introduction</u>*: Concept and environmental importance of EVs, HEVs and solar vehicles. *<u>Electric vehicles</u>*: Layout, construction and working. *<u>Hybrid electric vehicles:</u>* Types, layout, hybridization factor, plug in hybrid electric vehicles, fuel efficiency analysis. Challenges and future scope of EVs and HEVs.
Books
Text : 1. K. Newton and W. Seeds, T.K. Garrett, “Motor Vehicle”, 13thEdition, Elsevier publications. 2. Hans Hermann Braess, Ulrich Seiffen, “Handbook of Automotive Engineering”, SAE Publications. 3. William H. Crouse., “Automotive Mechanics”, Tata McGraw Hill Publishing House. 4. Joseph Heitner, “Automotive Mechanics”, C.B.S Publishers and Distributors. 5. SAE Manuals and Standards. 6. .N. K. Giri, Automobile Mechanics 7. P. S. Kohali, Automobile Electrical Equipment, Tata McGraw Hill Publishing House. 8. Narang G. B. S, “Automobile Engineering”, S. Chand and Company Ltd.
References : 1. Dr. Kirpal Singh, “Automobile Engineering”, Volume 1, Standard Publishers distributors. 2. Automobile Mechanics, “Crouse/Anglin”, TATA Mcgraw-Hill. 3. R. B. Gupta, Automobile Engineering, Satya Prakashan.

4. Chris Mi, M .Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, ,Willey.
5. Electric and Hybrid Vehicles, Tom Denton, Routledge.
6. Hybrid Electric Vehicle Technology, Automotive Research and Design, American Technical.
7. Husain, Iqbal, Electric and hybrid vehicles, 2 edition, CRC Press.
8. Ron Hodkinson and John Fenton, Butterworth-Heinemann.Lightweight Electric/ Hybrid Vehicle Design,
9. Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Standards media.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402045 B **Course Name : Elective – II Operation Research**

Teaching Scheme:		**Credits**		**Examination Scheme:**		
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR : --**
Practical	**: --**	**TW**	**: --**		**End-Sem : 70**	**OR : --**
						TW : --

Pre-requisites	Mathematics I, II and III

Course Objectives:

- To familiarize the students with the use of practice oriented mathematical applications for optimization functions in an organization.
- To familiarize the students with various tools of optimization, probability, statistics and simulation, as applicable in particular scenarios in industry for better management of various resources.

Course Outcomes:

On completion of the course, students will be able to -

- Apply LPP and Decision Theory to solve the problems
- Apply the concept of transportation models to optimize available resources.
- Decide optimal strategies in conflicting situations.
- Implement the project management techniques.
- Minimize the process time
- Optimize multi stage decision making problems

Course Contents

Unit 1: Introduction: Operation Research **6 Hrs**

Introduction: Definition, Evolution and Classification of Quantitative Methods and Operations Research Techniques, Methodology, Advantages and Limitations. Linear Programming Problem: Introduction, Formulation of LPP, Solution of LPP by Two Phase Method only. Decision Theory: Meaning and Steps in Decision Making, Types of Management Decisions, Decision under Certainty, under Risk, under Uncertainty, Decision Trees

Unit 2: Transportation & Assignment Model **6 Hrs**

Introduction, Formulation, Basic Method of Solving Transportation Problem, Optimization Methods like UV and Stepping Stone Method, Assignment Problem- Hungarian Method to solve Assignment Problem.

Unit 3: Theory of Games and Linear Programming **6 Hrs**

Theory of Games : Introduction, Minimax and Maximin Principle, Solution of Game with Saddle Point, Solution by Dominance, Solution by Graphical Method, m x n size Game Problem, Iterative method, Introduction to formulation of games using Linear Programming.

Replacement Analysis: Replacement of Items that Deteriorate, Replacement of Items that Fail

Suddenly.

Unit 4: Project Management **6 Hrs**

Network Models: Fulkerson‘s rule, concept and types of floats, CPM and PERT, Crashing Analysis and Resource Scheduling. Simulation: Introduction, Monte-Carlo Simulation method, Simulation of Inventory and Queuing Problems.

Unit 5: Queuing Theory and Sequencing Models **6 Hrs**

Queuing Theory: Introduction, Basis Structure, Terminology (Kendal‘s Notations) and Applications. *Queuing Model M/M/1*: /FIFO, M/M/c.

Sequencing models : Solution of sequencing Problem - Processing of n jobs through two machines, Processing of n jobs through three machines, Processing of two jobs through m Machines, Processing of n jobs through m Machines

Unit 6: Integer and Dynamic Programming **6 Hrs**

Integer Programming Introduction to Integer Programming, Cutting plane method and Branch and Bound Method. Dynamic Programming: Introduction, DP Model, Applications of DP Model to shortest route problems. Solution of LPP by Dynamic Programming

Books

Text :

1. Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
2. J. K. Sharma, Operations Research: Theory and Application, Laxmi pub. India.
3. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut.
4. L.C.Jhamb,Quantative Techniques Vol. I&II, Everest Publication.
5. Manohar Mahajan, Operation Research, Dhanpatrai Publication

References :

1. Hillier F.S., and Lieberman G.J., Operations Research, Eight Edition, Mc. Tata McGraw Hill, India
2. Ravindran, ―Engineering optimization Methods and Applications‖, 2nd edition, Wiley, India
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Second Edition, Mc. WSE Willey,
4. Operations Research - An introduction, Hamdy A Taha, Pearson Education.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402045 C | **Course Name : Elective – II Energy Audit and Management**

Teaching Scheme:		**Credits**		**Examination Scheme:**			
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR**	**: --**
Practical	**: --**	**TW**	**: --**		**End-Sem : 70**	**OR**	**: --**
						TW	**: --**

Pre-requisites:	Thermodynamics, Turbo Machines

Course Objectives:

Following concepts to be taught to the students,

- Importance of Energy Management.
- To Carry out Energy Audit.
- Methods to reduce consumption of energy and save cost.
- To improve energy efficiency of overall system.
- Significance of Waste heat recovery and Cogeneration.

Course Outcomes:

On completion of the course, students will be able to -

- Compare energy scenario of India and World.
- Carry out Energy Audit of the Residence / Institute/ Organization.
- Evaluate the project using financial techniques
- Identify and evaluate energy conservation opportunities in Thermal Utilities.
- Identify and evaluate energy conservation opportunities in Electrical Utilities.
- Identify the feasibility of Cogeneration and WHRUse a CFD tool effectively for practical problems and research.

Course Contents

Unit 1: General Aspects of Energy Management **6 Hrs**

Current energy scenario - India and World, Current energy consumption pattern in global and Indian industry, Concept of energy conservation and energy efficiency, Energy and environment, Need of Renewable energy, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy reforms.

Unit 2: Energy Audit **6 Hrs**

Need of Energy Audit, Types of energy audit, Components of energy audit, Energy audit methodology, Instruments used in energy audit, Analysis and recommendations of energy audit, Energy audit reporting, Energy audit software, Current Energy Conservation Act.

Unit 3: Energy Economics **6 Hrs**

Costing of Utilities- Determination of cost of steam, natural gas, compressed air and electricity, Financial Analysis Techniques (Numerical) - Simple payback, Time value of money, Net Present Value(NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Risk and Sensitivity analysis.

Unit 4: Energy Efficiency in Thermal Utilities **6 Hrs**

Energy performance assessment (Numerical) and efficiency improvement of Boilers, Furnaces, Heat exchangers, Cooling tower, DG sets, Fans and blowers, Pumps, Compressors, Compressed air system and HVAC systems. Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.

Unit 5: Energy efficiency in Electrical Utilities **6 Hrs**

Electricity billing, Electrical load management and maximum demand control, penalties, Power factor improvement and benefits, Selection and location of capacitors. Distribution and transformer losses, Electrical motors- types, efficiency and selection, Speed control, Energy efficient motors, Introduction of Electricity Act 2003,Lamp types and their features, recommended illumination levels, Lighting system performance assessment and efficiency improvement (Numerical)

Unit 6: Cogeneration and Waste Heat Recovery **6 Hrs**

Cogeneration : Need, applications, advantages, classification, Introduction to Trigeneration, Waste heat recovery- Classification, Application, Concept of Pinch analysis, Potential of WHR in Industries, Commercial WHR devices, saving potential. CDM projects and carbon credit calculations.
Case study: Energy Audit of Institute/Department.

Books

References :

1. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, The Fairmont Press Inc., 7th Edition.
2. Energy Management Handbook, Wayne C. Turner, The Fairmont Press Inc., 5th Edition, Georgia.
3. Handbook on Energy Audit and Environment management, Abbi Y. A., Jain Shashank, TERI, Press, New Delhi, 2006
4. Energy Performance assessment for equipment and Utility Systems.-Vol. 2,3.4 BEE Govt. of India
5. Boiler Operator‘s Guide Fourth Edition, Anthony L Kohan, McGraw Hill
6. Energy Hand book, Second edition, Von Nostrand Reinhold Company - Robert L. Loftness.
7. www.enrgymanagertraining.com
8. http://www.bee-india.nic.in

Savitribai Phule Pune University

Final Year of Mechanical Engineering (2015 Course)

Course Code : 402046 **Course Name : Project – I**

Teaching Scheme:		Credits		Examination Scheme:		
Theory	**: --**	**TH**	**: --**	**Theory**	**In-Sem : --**	**PR : --**
Practical	**: 04 hrs per week**	**TW**	**: 02**		**End-Sem : --**	**OR : 25**
						TW : 25

Course Objectives:

- To have ideology of the industrial project.
- Hands on working with tools, tackles and machines
- To carry out literature survey
- To do brain storming for mechanical engineering system

Course Outcomes:

On completion of the course, students will be able to -

- Find out the gap between existing mechanical systems and develop new creative new mechanical system.
- Learn about the literature review
- Get the experience to handle various tools, tackles and machines.

Course Contents

INSTRUCTIONS FOR PROJECT REPORT WRITING (Project Stage I)

It is important that the procedures listed below be carefully followed by all the students of B.E. (Mechanical Engineering).

1. Prepare ***Three Spiral Bound Copies*** of your manuscript.
2. Limit your Project Stage I to *25– 30* pages (preferably)
3. The *footer must include* the following:
   Institute Name, B.E. (Mechanical) Times New Roman 10 pt. and centrally aligned.
4. Page number as second line of footer, Times New Roman 10 pt. centrally aligned.
5. Print the manuscript using
   a) Letter quality computer printing.
   b) The main part of manuscript should be Times New Roman 12 pt. with alignment - justified.
   c) Use 1.5 line spacing.
   d) Entire report shall be of 5- 7 chapters
6. Use the paper size 8.5’’ × 11’’ or A4 (210 × 197 mm). Please follow the margins given below.

Margin Location	**Paper 8.5’’ × 11’’**	**Paper A4 (210 × 197 mm)**
Top	1’’	25.4 mm
Left	1.5’’	37 mm
Bottom	1.25’’	32 mm
Right	1’’	25.4 mm

7. All paragraphs will be *1.5 lines spaced with a one blank line between each paragraph*. Each paragraph will begin with *without any indentation*.
8. *Section titles* should be bold with *14 pt.* typed in all capital letters and should be left aligned.
9. *Sub-Section headings* should be aligning at the left with *12 pt.* bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, black and white. Illustrations downloaded from internet are not acceptable.
    a) Illustrations should not be more than two per page. One could be ideal
    b) Figure No. and Title at bottom with 12 pt.
    c) Table No. and Title at top with 12 pt.
    d) Legends below the title in 10 pt.
    e) Leave proper margin in all sides
    f) Illustrations as far as possible should not be photo copied.
11. Photographs if any should be of glossy prints
12. Please use SI system of units only.
13. Please number the pages on the front side, centrally below the footer
14. References should be either in order as they appear in the thesis or in alphabetical order by last name of first author
15. Symbols and notations if any should be included in nomenclature section only
16. Following will be the order of report
    i. Cover page and Front page (*as per the specimen on separate sheet*)
    ii. Certificate from the Institute (*as per the specimen on separate sheet*)
    iii. Acknowledgements
    iv. Contents
    v. List of Figures
    vi. List of Tables
    vii. Nomenclature
    viii. Abstract (A brief abstract of the report not more than 150 words. The heading of abstract i.e. word “Abstract” should be bold, Times New Roman, 12 pt. and should be typed at the center. The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on motive, method, key-results and conclusions in Abstract
    1. Introduction (2-3 pages) (TNR – 14 Bold)
        1.1 Problem statement (TNR – 12)
        1.2 Objectives
        1.3 Scope
        1.4 Methodology
        1.5 Organization of Dissertation
    2. Literature Review (12-16 pages)
    Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.
    3. This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (8 - 12 pages)
    4. Experimental Validation - This chapter shall be based on your own experimental work

(2 - 3 pages)

5. Concluding Remarks and Scope for the Future Work (1 - 2 pages)
(IF above Chapters 3, 4, 5 not completed please mention the plan for the same and time period for completion and detail activity chart).
References ANNEXURE (if any) (Put all mathematical derivations, Simulation program as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers 1, 2, 3, …. and for subheadings 1.1, 1.2, …. etc and section subheadings 2.1.1, 2.1.2, …. etc.
18. References should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If figures and tables are taken from any reference then indicate source / citatation of it. Please follow the following procedure for references

Reference Books :
Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions :
Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.
Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings :
Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc. :
United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.
ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent :
Patent no, Country (in parenthesis), date of application, title, year.

Internet :
www.(Site) [Give full length URL] *accessed on date*

A Project Stage-I Report on
(TNR, 16pt, centrally aligned)

Title of the Project Report

(TNR, 27pt, Bold, Centrally Aligned, Title Case)

By
(TNR, 16pt, Centrally Aligned)

Mr. Student's 1 Name
(TNR, 16pt, Centrally Aligned)

Mr. Student's 2 Name
(TNR, 16pt, Centrally Aligned)

Mr. Student's 3 Name
(TNR, 16pt, Centrally Aligned)

Mr. Student's 4 Name
(TNR, 16pt, Centrally Aligned)

Guide
Guide's Name
(TNR, 16pt, Centrally Aligned)

Institute Logo

Department of Mechanical Engineering
Name of the Institute

[2018-19]
(TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute Logo

C E R T I F I C A T E

This is to certify that ***Mr. (Name of the Student)***, has successfully completed the Project Stage – I entitled "(***Title of the Project)*** " under my supervision, in the partial fulfillment of Bachelor of Engineering - Mechanical Engineering of University of Pune.

Date:

Place:

Guide's Name
Guide

Internal Examiner

HoD Name
Head of the Department

Principal Name
Principal

Seal

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402047 **Course Name : Energy Engineering**

Teaching Scheme:		**Credits**		**Examination Scheme:**			
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR**	**: --**
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR**	**: 25**
						TW	**: 25**

Pre-requisites:	Thermodynamics I and II and Heat Transfer

Course Objectives:

- To study the power generation scenario, the components of thermal power plant, improved Rankin cycle, Cogeneration cycle
- To understand details of steam condensing plant, analysis of condenser, the an environmental impacts of thermal power plant, method to reduce various pollution from thermal power plant
- To study layout, component details of hydroelectric power plant, hydrology and elements , types of nuclear power plant
- To understand components; layout of diesel power plant , components; different cycles ; methods to improve thermal efficiency of gas power plant
- To study the working principle , construction of power generation from non-conventional sources of energy
- To learn the different instrumentation in power plant and basics of economics of power generation.

Course Outcomes:

On completion of the course, students will be able to -

- Describe the power generation scenario, the layout components of thermal power plant and analyze the improved Rankin cycle, Cogeneration cycle
- Analyze the steam condensers, recognize the an environmental impacts of thermal power plant and method to control the same
- Recognize the layout, component details of hydroelectric power plant and nuclear power plant
- Realize the details of diesel power plant, gas power plant and analyze gas turbine power cycle
- Emphasize the fundaments of non-conventional power plants
- Describe the different power plant electrical instruments and basic principles of economics of power generation.

Course Contents

Unit 1: Introduction and Thermal Power Plant **6 Hrs**

A) *Power Generation* : global scenario, present status of power generation in India, in Maharashtra, Role of private and governmental organizations, load shedding, carbon credits, pitfalls in power reforms, concept of cascade efficiency.

B) *Thermal Power Plant* : General layout of modern thermal power plant with different circuits, site selection criteria, classification of coal, coal blending, coal beneficiation, selection of coal for thermal power plant, slurry type fuels, pulverized fuel handling systems, fuel burning methods, FBC systems, high pressure boilers, ash handling system, Rankine cycle with reheat and regeneration (Numerical Treatment), steam power plants with process heating (Numerical Treatment)

Unit 2: Steam Condenser and Environmental Impacts of Thermal Power Plant **6 Hrs**

A) *Steam Condenser* : Necessity of steam condenser, elements of steam condensing plant, classification, cooling water requirements, condenser efficiency, vacuum efficiency (Numerical Treatment), cooling towers, air leakage and its effects on condenser performance, air pumps (Numerical Treatment for Air Pump capacity)

B) *Environmental impact of thermal power plants* : Different pollutants from thermal power plants, their effects on human health and vegetation, methods to control pollutants such as particulate matter; oxides of sulphur; oxides of nitrogen, dust handling systems, ESP, scrubbers, water pollution, thermal pollution, noise pollution from TPP and its control

Unit 3: Hydroelectric and Nuclear Power Plant **6 Hrs**

A) *Hydroelectric Power Plant* : site selection, classification of HEPP (based on head, nature of load, water quantity), criteria for turbine selection, dams, spillways, surge tank and forebay, advantages and disadvantages of HEPP, hydrograph ,flow duration curve ,mass curve, (Numerical Treatment) environmental impacts of HEPP

B) *Nuclear Power Plants* : elements of NPP, types of nuclear reactor (PWR, BWR, CANDU, GCR, LMCR, OMCR, fast breeder, fusion), material for nuclear fuel, cladding, coolants, control rod and shielding, nuclear waste disposal, environmental impacts of NPP

Unit 4: Diesel and Gas Turbine Power plant **6 Hrs**

A) *Diesel Power Plants* : applications, components of DPP, different systems of DPP, plant layout, performance of DPP (Numerical Treatment) advantages & disadvantages of diesel power plant, environmental impacts of DPP

B) *Gas Turbine Power Plant* : general layout of GTPP, components of GTPP, open, closed & semi-closed cycle gas turbine plant, Brayton cycle analysis for thermal efficiency, work ratio, maximum & optimum pressure ratio, methods to improve thermal efficiency of GTPP: inter-cooling; reheating & regeneration cycle (numerical treatment), gas and steam turbine combined cycle plant, environmental impacts of GTPP

Unit 5: Non-Conventional Power Plants **6 Hrs**

*Solar Power Plant based on***:** flat plate collector, solar ponds, parabolic solar collector, heliostat, solar chimney, SPV cell based plants: working principal, solar photovoltaic systems, applications

*Geothermal Plant***:** superheated steam system, flash type, binary cycle plant.

*Tidal Power Plant***:** components, single basin, double basin systems.

*OTEC Plant***:** principal of working, Claude cycle, Anderson Cycle.

MHD Power Generation : Principal of working, Open Cycle MHD generator, closed cycle MHD generators.

Fuel cell : alkaline, acidic, proton-exchange membrane

Wind Power Plant : wind availability, wind mills and subsystems, classification of wind turbines, operating characteristics, wind solar hybrid power plants, challenges in commercialization of non-conventional power plants, environmental impacts of NCPP

Unit 6: Instrumentation and Economics of Power Plant **6 Hrs**

A) *Power Plant Instruments* : layout of electrical equipment, generator, exciter, generator cooling, short circuits & limiting methods, switch gear, circuit breaker, power transformers, methods of earthling, protective devices & control system used in power plants, measurement of high voltage, current and power, control room

B) *Economics of Power Generation* : cost of electric energy, fixed and operating cost [methods to determine depreciation cost] (Numerical Treatment), selection and type of generation, selection of generation equipment , load curves, performance and operation characteristics of power plants, load division, all terms related to fluctuating load plant (Numerical Treatment)

Books

Text :

1. Domkundwar & Arora, Power Plant Engineering, Dhanpat Rai & Sons, New Delhi
2. Domkundwar & Domkundwar- Solar Energy and Non-Conventional Sources of Energy, Dhanpat Rai& Sons, New Delhi.
3. R.K.Rajput, Power Plant Engineering‖, Laxmi Publications New Delhi.
4. D.K.Chavan & G.K.Phatak, Power Plant Engineering‖, Standard Book House, New Delhi.

References :

1. E.I.Wakil, Power Plant Engineering‖, McGraw Hill Publications New Delhi
2. P.K.Nag, Power Plant Engineering‖, McGraw Hill Publications New Delhi.
3. R.Yadav , Steam and Gas Turbines‖ ,Central Publishing House, Allahabad.
4. G.D.Rai, Non-Conventional Energy Sources, Khanna Publishers,Delhi
5. S.P.Sukhatme, Solar Energy‖ Tata McGraw-Hill Publications, New Delhi
6. G R Nagpal Power Plant Engineering , Khanna Publication

Term Work shall consist of following assignments:

IMP Notes for Term Work:

- Any Eight Experiment should be conducted (*from Experiment No. 1 to 10*) and
- *Experiment No 1, 2, 7,* and *8* are compulsory
- *Experiment No: 3 - 9* can be performed using suitable simulation software

1. Visit to Thermal Power plant /Co-generation Power plant.
2. Visit to HEPP/GTPP/Non-Conventional Power Plants.
3. Study of Fluidized Bed Combustion system.
4. Study of High Pressure Boilers
5. Study of Steam Turbine Systems –governing systems, protective devices, lubricating systems, glands and sealing systems.
6. Study of Co-generation Plants
7. Trial on Steam Power Plant or with help of suitable software to determine
   a) Plant Efficiency, Rankine Efficiency Vs Load
   b) Specific Steam consumption Vs Load
   c) Rate of Energy Input Vs Load
   d) Heat Rate and Incremental heat Rate Vs Load
8. Trial on Diesel Power Plant or with help of suitable software to determine
   a) Plant Efficiency Vs Load

b) Total fuel consumption Vs Load
c) Rate of Energy Input Vs Load
d) Heat Rate and Incremental heat Rate Vs Load

9. Study of Power Plant Instruments.
10. Study of Different Tariff Methods

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402048 **Course Name : Mechanical System Design**

Teaching Scheme:		**Credits**		**Examination Scheme:**			
Theory	**: 04 Hrs Per Week**	**TH**	**: 04**	**Theory**	**In-Sem : 30**	**PR**	**: --**
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR**	**: 25**
						TW	**: 50**

Pre-requisites:	Engineering Mechanics, Manufacturing Process, Strength of Materials, Machine design, Engineering Mathematics, Theory of Machines, Dynamics of Machinery, and IC Engines.

Course Objectives:

- To develop competency for system visualization and design.
- To enable student to design cylinders and pressure vessels and to use IS code.
- To enable student select materials and to design internal engine components.
- To introduce student to optimum design and use optimization methods to design mechanical components.
- To enable student to design machine tool gearbox.
- To enable student to design material handling systems.
- Ability to apply the statistical considerations in design and analyze the defects and failure modes in components

Course Outcomes:

On completion of the course, students will be able to -

- Understand the difference between component level design and system level design.
- Design various mechanical systems like pressure vessels, machine tool gear boxes, material handling systems, etc. for the specifications stated/formulated.
- Learn optimum design principles and apply it to mechanical components.
- Handle system level projects from concept to product.

Course Contents

Unit 1: Design of Machine Tool Gear Box **8 Hrs**

Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, gearing diagram, deviation diagram.
(Note: Full design problem to be restricted up to 2 Stages only)

Unit 2: Statistical Consideration in Design **8 Hrs**

Frequency distribution-Histogram and frequency polygon, normal distribution - units of central tendency and dispersion- standard deviation - population combinations - design for natural tolerances - design for assembly - statistical analysis of tolerances, mechanical reliability and factor of safety.

Unit 3: Design of Belt Conveyor System for Material Handling **8 Hrs**

System concept, basic principles, objectives of material handling system, unit load and

containerization.
Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.

Unit 4: Design of Cylinders and Pressure Vessels **8 Hrs**

Design of Cylinders: Thin and thick cylinders, Lame's equation, Clavarino's and Bernie's equations, design of hydraulic and pneumatic cylinders, auto-frettage and compound cylinders,(No Derivation) gasketed joints in cylindrical vessels (No derivation).
Design of Pressure vessel : Modes of failures in pressure vessels, unfired pressure vessels, classification of pressure vessels as per I. 2825 - categories and types of welded joints, weld joint efficiency, stresses induced in pressure vessels, materials for pressure vessel, thickness of cylindrical shells and design of end closures as per code, nozzles and openings in pressure vessels, reinforcement of openings in shell and end closures - area compensation method, types of vessel supports (theoretical treatment only).

Unit 5: Design of I.C. Engine Components **8 Hrs**

Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, construction of cylinder liners, design of piston and piston-pins, piston rings, design of connecting rod. Design of crank-shaft and crank-pin, (Theoretical treatment only).

Unit 6: Optimum Design **8 Hrs**

Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equations, subsidiary design equations and limit equations, optimum design with normal specifications of simple machine elements- tension bar, transmission shaft and helical spring, Pressure vessel Introduction to redundant specifications (Theoretical treatment).

Books

Text :

1. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.
2. Juvinal R.C, Fundamentals of Machine Components Design, Wiley, India

References :

1. Design Data- P.S.G. College of Technology, Coimbatore.
2. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd.
3. I.S. 2825: Code for unfired pressure vessels.
4. Shigley J. E. and Mischke C.R., ―Mechanical Engineering Design‖, McGraw Hill Pub. Co
5. M. F. Spotts, –Mechanical Design Analysis‖, Prentice Hall Inc.
6. Black P.H. and O. Eugene Adams, –Machine Design‖ McGraw Hill Book Co. Inc.
7. Johnson R.C., ―Mechanical Design Synthesis with Optimization Applications‖, Von Nostrand Reynold Pub.
8. S.K. Basu and D. K. Pal, –Design of Machine Tools, Oxford and IBH Pub Co.
9. Rudenko,‖Material Handling Equipment‖, M.I.R. publishers, Moscow
10. P. Kannaiah ,‖Design of Transmission systems‖, SCIETCH Publications Pvt Ltd.
11. Pandy, N. C. and Shah, C. S., Elements of Machine Design, Charotar Publishing House.
12. Mulani, I. G., ―Belt Conveyors‖
13. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons.

14. M.V. Joshi, Process Equipment Design, Mc-Millan.

Term Work shall consist of following assignments:

1. One Design Project:

The design project shall consist of two imperial size sheets (Preferably drawn with 3D/2D CAD software) - one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances must be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted. Projects shall be in the form of design of mechanical systems including pressure vessel, conveyor system, multi speed gear box, I.C engine, etc.

Each Student shall complete any one of the following assignments.

1. Design of Flywheel.
2. Design for Manufacture, Assembly and safe.
3. Application of Composite Material for different mechanical components.
4. Case study of one patent/ copyright/trademark from the product design point of view.
5. Design of Human Powered system.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402049 A **Course Name : Elective – III Tribology**

Teaching Scheme:		Credits		Examination Scheme:			
Theory	: 03 Hrs Per Week	TH	: 03	Theory	In-Sem : 30	PR	: --
Practical	: 02 hrs per week	TW	: 01		End-Sem : 70	OR	: --
						TW	: 25

Pre-requisites	: Physics, Chemistry, Mathematics, Fluid Mechanics, Theory of Machine and Machine Design

Course Objectives:

- To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components.
- To select proper grade lubricant for specific application.
- To understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
- To introduce the concept of surface engineering and its importance in tribology.
- To understand the behavior of Tribological components.

Course Outcomes:

On completion of the course, students will be able to -

- The course will enable the students to know the importance of Tribology in Industry.
- The course will enable the students to know the basic concepts of Friction, Wear, Lubrications and their measurements.
- This course will help students to know the performance of different types of bearings and analytical analysis thereof.
- This course will help students to apply the principles of surface engineering for different applications of tribology.

Course Contents

Unit 1: Introduction to Tribology **6 Hrs**

Importance of Tribology in Design, Tribology in Industry, Economic Considerations, Lubrication-Definition, Lubricant properties, Viscosity, its measurements- Numerical, basic modes of lubrication, types of lubricants, Standard Grades of lubricants, selection of lubricants, commonly used lubricants and Hazards, Recycling of used oil, Disposal of used oil, bearing materials, bearing construction, oil seals and gaskets.

Unit 2: Friction and Wear **5 Hrs**

Introduction, Laws of friction, kinds of friction, causes of friction, area of contact, friction measurement, theories of friction.

Types of wear, various factors affecting wear, measurement of wear, wear between solids and flowing liquids, theories of wear

Unit 3: Hydrodynamic Lubrication **7 Hrs**

Theory of hydrodynamic lubrication, mechanism of pressure development in an oil film. Two dimensional Reynolds equation, Petroff's equation, pressure distribution in journal bearings - long & short, Load Carrying capacity, Somerfield number and its importance- Numerical. Introduction to Hydrodynamic Thrust Bearing

Unit 4: Hydrostatic Lubrication **5 Hrs**

Introduction to hydrostatic lubrication, hydrostatic step bearing, load carrying capacity and oil flow through the hydrostatic step bearing- Numerical.

Hydrostatic squeeze film : basic concept, circular and rectangular plate approaching a plane- Numerical

Unit 5: Elasto-hydrodynamic lubrication and Gas Lubrication **5 Hrs**

Elasto - hydrodynamic lubrication: Basic concept, Elasto-hydrodynamic lubrication between two contacting bodies, different regimes in EHL contacts.

Gas lubrication: Introduction, merits and demerits, applications, externally pressurized gas bearings, porous gas bearings, and Dynamic characteristics of gas lubricated bearing.

Unit 6: Surface Engineering **8 Hrs**

Concept and scope of Surface engineering, surface topography, apparent and real area of contact, tribological behavior of asperities contact- contact stress, surface roughness and hydrodynamic action- Numerical, surface coating-plating, fusion process, vapor phase processes, selection of coating for wear and corrosion resistance. Behavior of tribological components- selection of bearings, plain bearings, gears, wire ropes, seals and packings, conveyor belts, other tribological measures.

Books

Text :

1. Basu S.K., Sengupta S. N. and Ahuja B.B. "Fundamentals of Tribology" PHI Learning, Ltd. India.
2. Majumdar B. C. "Introduction to Tribology and Bearings", S. Chand and Company Ltd., New Delhi.

References :

1. Bharat Bhushan, "Principles and Applications of Tribology", John Wiley and Sons.
2. Sahu P., "Engineering Tribology", PHI Learning, Ltd. India
3. Fuller D.D. "Theory and Practice of Lubrication for Engineers". John Wiley and Sons.
4. Neale M. J. "Tribology hand Book", Butterworths. London.
5. Orlov P., "Fundamentals of Machine Design", Vol. IV, MIR Publication.
6. Cameron A. "Basic Lubrication Theory", Wiley Eastern Ltd.
7. 'Hailing J., "Principles of Tribology", McMillan Press Ltd., 1975.
8. Ghosh M.K., Mujumdar B.C. and Sarangi M., "Theory of lubrication", Tata McGraw Hill Education Pvt. Ltd., New Delhi.

Term Work shall consist of following assignments:

A] *Any one case study of the following*

1. Friction in sliding/ rolling contact bearing.
2. Wear of cutting tool.
3. Surface Coating.
4. Sliding/ rolling contact bearing Performance

B] Assignment based on the Tribological design of the system like I C Engine, Machine Tool, Rolling Mill.

OR

Industrial Visit: Students should visit the industry to study the lubrication systems or to study the techniques of surface coating.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402049 B **Course Name : Elective – III Industrial Engineering**

Teaching Scheme:		**Credits**		**Examination Scheme:**		
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR : --**
Practical	**: 02 hrs per week**	**TW**	**: 01**		**End-Sem : 70**	**OR : --**
						TW : 25

Pre-requisites:	NIL

Course Objectives:

- To introduce the concepts, principles and framework of contents of Industrial Engineering.
- To acquaint the students with various productivity enhancement techniques.
- To acquaint the students with different aspects of Production Planning and Control and Facility Design.
- To introduce the concepts of various cost accounting and financial management practices as applied in industries.
- To acquaint the students with different aspects of Human Resource activities and Industrial Safety rules.
- To acquaint students with different aspect of simulation modeling for various industrial engineering\applications.

Course Outcomes:

On completion of the course, students will be able to -

- Apply the Industrial Engineering concept
- Understand, analyze and implement different concepts involved in method study.
- Design and Develop different aspects of work system and facilities.
- Understand and Apply Industrial safety standards, financial management practices.
- Undertake project work based on modeling & simulation area.

Course Contents

Unit 1: Introduction to Industrial Engineering and Productivity **6 Hrs**

Definition and Role of Industrial Engineering, Types of production systems and organization structure, Functions of management.

*Measurement of productivity***:** Factors affecting the productivity, Productivity Models and Index (Numerical), Productivity improvement techniques.

Note: *Productivity improvement techniques viz. 5S, Kaizen, TPS, KANBAN, JIT, etc. shall be discussed at the end of this* Unit.

Unit 2: Method Study **6 Hrs**

Work Study: Definition, objective and scope of work-study, Human factors in work-study.
Method Study: Definition, objective and scope of method study, work content, activity recording and exam aids.
Charts to record movements: Operation process charts, flow process charts, travel chart, two-handed chart and multiple activity charts. Principles of motion economy, classification of movements, SIMO chart, and micro motion study.
Definition and installation of the improved method, brief concept about synthetic motion studies.
Introduction to Value Engineering and Value Analysis.

Unit 3: Work Measurements **6 Hrs**

Work Measurements: Definition, objectives and uses, Work measurement techniques.
Work Sampling: Need, confidence levels, sample size determinations, random observation, conducting study with the simple problems.
Time Study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information, Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination.
Introduction to PMTS and MTM: (Numerical), Introduction to MOST.

Unit 4: Production Planning and Control **6 Hrs**

Introduction: Types of production systems, Need and functions of PPC, Aggregate production planning.
Capacity Planning, ERP: Modules, Master Production Schedule, MRP and MRP-II.
Forecasting Techniques: Causal and time series models, moving average, exponential smoothing, trend and seasonality (Numerical), Demand Control strategies (MTO, MTA, MTS).
Introduction to Supply Chain Management: Basic terminologies.

Unit 5: Facility Design **6 Hrs**

Plant Location : Need and factors influencing plant location,
Plant Layout: Objectives, principles, types of plant layouts, Introduction to Assembly Line Balancing and Layout parameters to evaluate.
Material Handling: Objectives, relation with plant layout, principles. Types and purpose of different material handling equipment, Selection of material handling equipment.
Inventory control and Management: Types of inventories, Need of inventories, terminology, costs, Inventory Models: Basic production models, (with and without shortage and discount), ABC, VED Analysis.

Unit 6: Engineering Economy, Human Resource and Industrial Safety **6 Hrs**

Introduction to Costing: Elements of Cost, Break-Even Analysis (Numerical).
Introduction to Debit and Credit Note, Financial Statements (Profit and loss account and Balance Sheet), Techniques for Evaluation of capital investments.
Human Resource Development: Functions: Manpower Planning, Recruitment, Selection, Training. Concept of KRA (Key Result Areas), Performance Appraisal (Self, Superior, Peer, 3600).
Industrial Safety: Safety Organization, Safety Program

Books

Text :

1. M Mahajan, Industrial Engineering and Production Management, Dhanpat Rai and Co.
2. O. P. Khanna, Industrial engineering and management, Dhanpat Rai publication
3. Martend Telsang, Industrial Engineering, S. Chand Publication.
4. Banga and Sharma, Industrial Organization& Engineering Economics, Khanna publication.

References :

1. Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBHPublishing Company, New Delhi, Second Indian Adaptation, 2008.
2. H. B. Maynard, K Jell, Maynard‘s Industrial Engineering Hand Book, McGraw Hill Education.
3. Askin, Design and Analysis of Lean Production System, Wiley, India
4. Zandin K.B., Most Work Measurement Systems, ISBN 0824709535, CRCPress,2002
5. Martin Murry, SAP ERP: Functionality and Technical Configuration, SAP Press; 3rdNew edition (2010).
6. Barnes, Motion and time Study design and Measurement of Work, Wiley India
7. Raid Al-Aomar, Adwerd J Williams, Onur M. Uigen ‘Process Simulation using WITNESS’, Wiley

Term Work shall consist of following assignments:

- Minimum of *8 Experiments* are compulsory from the following list of Experiments.
- Assignment number *1*, *2*, *3*, *8* and *12* are compulsory.
- It is advisable that, students shall collect data by visiting suitable industry to complete following assignments (*Per batch of Max. 20 students*)
- For completing above assignments *any suitable simulation software* like WITNESS can be used

1. Case study based Assignment on Method Study.
2. Hands on Assignment on application of Work Measurement technique(s).
3. Assignment on simulation of Routing & Scheduling Model
4. Assignment on **s**imulation of Manufacturing System **/** Service System Operations for demand forecasting of the given product using any two methods.
5. Assignment on simulation determination of EOQ and plot the graphs.
6. Assignment on analysis of Manufacturing / Service Operation for Capacity Planning.
7. Case study based assignment on supply chain model.
8. Assignment on analysis of (selected) plant layout modeling and simulation for bottleneck / line balancing.
9. Assignment on analysis of material handling system - modeling simulation for the selected plant layout.
10. Case study based assignment on identification of Key Result Areas for performance appraisal for selected company (3600 feedback).
11. Case study based assignment on cost-revenue model analysis.
12. Assignment on industrial safety audit of selected work environment.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402049 C **Course Name : Elective – III Robotics**

Teaching Scheme:		Credits		Examination Scheme:		
Theory	: 03 Hrs Per Week	TH	: 03	Theory	In-Sem : 30	PR : --
Practical	: 02 hrs per week	TW	: 01		End-Sem : 70	OR : --
						TW : 25

Pre-requisites:	Engineering Mechanics, TOM, Mechatronics, Basics of Electrical and Electronics Engineering, Control system.

Course Objectives:

- To get acquainted with basic components of robotic systems.
- To study various gripper mechanisms and sensors and understand role of suitable control system.
- To understand statistics & kinematics of robots
- To develop competency in obtaining desired motion of the robot.
- To study various programming methods in robotics.
- To understand need of modern techniques in robotics.

Course Outcomes:

On completion of the course, students will be able to -

- Identify different type of robot configuration with relevant terminology.
- Select suitable sensors, actuators and drives for robotic systems.
- Understand kinematics in robotic systems.
- Design robot with desired motion with suitable trajectory planning.
- Select appropriate robot programming for given application.
- Understand need of IoT, machine learning, simulation in robotics.

Course Contents

Unit 1: **6 Hrs**

Introduction: Basic Concepts, laws of Robotics, Robot anatomy, Classification, structure of robots, point to point and continuous path robotic systems. Robot performance- resolution, accuracy, repeatability, dexterity, compliance, RCC device, Applications.

Robot Grippers: Types of Grippers, Design of gripper, Force analysis for various basic gripper systems including Mechanical, Hydraulic and Pneumatic systems.

Unit 2: **6 Hrs**

Robotic Sensors: Characteristics of sensing devices, Classification, Selection and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot. GPS, IMU, Vision, PVDF Tactile (construction, working and selection)

Drives and Control Systems : Types and selection of Drives, Actuators and transmission systems, Types of Controllers, closed loop control, second order linear systems and their control, control law of partitioning, trajectory-following control, modeling and control of a single joint, force control.

Unit 3: **6 Hrs**

Kinematics : Transformation matrices and their arithmetic, link and joint description, Denavit–Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics of two joints, solvability, algebraic and geometrical methods.

*Velocities and Static Forces in Manipulators***:** Motion of the manipulator links, Jacobians, singularities, static forces, Jacobian in force domain.

Unit 4: **6 Hrs**

Introduction to Dynamics, Trajectory generations, Motion planning and control: Joint and Cartesian space trajectory planning and generation, potential field method for motion planning Manipulator Mechanism Design, Force control and hybrid position/force control

Unit 5: **6 Hrs**

Machine Vision System: Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image Processing Techniques, Masking, Sampling and quantization, Noise reduction methods, Edge detection, Segmentation.

Robot Programming : Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Robot language structure, Introduction to various types such as RAIL and VAL II

Unit 6: **6 Hrs**

*Artificial Intelligence***:** Introduction, Need and Application, Problem solving through forward and backward search.

Introduction to Internet of Things (Industrial control, Smart Social Network), Industry 4.0, Machine learning

Simulation : Need of simulation, tools, types and techniques of simulation

Books

Text :

1. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.

References :

1. Groover M.P.-Automation, production systems and computer integrated manufacturing‘ - Prentice Hall of India
2. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
4. Mathia, Robotics for Electronics Manufacturing, Cambridge Uni. Press, India
5. A Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2013.
6. R K Mittal & I J Nagrath, Robotics and Control, McGraw Hill Publication, 2015.

7. K Astrom & T Hagglund, PID Controllers: Theory, Design and Tuning, 2nd Edition, The Instrumentation, Systems, and Automation Society, 1995.
8. Asfahl, Robots and Manufacturing Automation, Wiley, India, 2012
9. S. K. Saha, Introduction to Robotics, TMH International
10. Ganesh Hegde, Industrial Robotics, Laxmi publication
11. www.roboanalyzer.com

Term Work shall consist of following assignments:

The term work shall consist of detailed report on ***any five*** *of the following practical, essentially with one demonstration, one gripper design and an industrial visit.*

1. Simulation of Cartesian / Cylindrical/Spherical robot.
2. Simulation of Articulated / SCARA robot.
3. Virtual modeling for kinematic and dynamic verification any one robotic structure using suitable software.
4. Design, modeling and analysis of two different types of gripper.
5. Program for linear and non-linear path.
6. Report on industrial application of robot /Industrial visit.

Savitribai Phule Pune University

Final Year of Mechanical Engineering (2015 Course)

Course Code : 402050 A **Course Name : Elective – IV**

Advanced Manufacturing Processes

Teaching Scheme:		**Credits**		**Examination Scheme:**			
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR**	**: --**
Practical	**: --**	**TW**	**: --**		**End-Sem : 70**	**OR**	**: --**
						TW	**: --**

Pre-requisites:	Basic Engineering Science - Physics, Chemistry, Material Science, Engineering Metallurgy, Manufacturing processes

Course Objectives:

- To analyze and identify applications of special forming processes
- To analyze and identify applications of advanced joining processes
- To understand and analyze the basic mechanisms of hybrid non-conventional machining techniques
- To understand various applications and methods of micro and nano fabrication techniques
- To understand advanced Additive Manufacturing (AM) technology for innovations in product development
- To understand various material characterization techniques.

Course Outcomes:

On completion of the course, students will be able to -

- Classify and analyze special forming processes
- Analyze and identify applicability of advanced joining processes
- Understand and analyze the basic mechanisms of hybrid non-conventional machining techniques
- Select appropriate micro and nano fabrication techniques for engineering applications
- Understand and apply various additive manufacturing technology for product development
- Understand material characterization techniques to analyze effects of chemical composition, composition variation, crystal structure, etc.

Course Contents

Unit 1: Special Forming Processes **6 Hrs**

Principle, Machines, Process variables, characteristics, advantages, limitations and application of High Energy Rate Forming process (HERF), High Velocity Forming (HVF), Explosive forming, Magnetic pulse forming, Electro hydraulic forming, Metal spinning, Flow forming, Stretch forming, Incremental sheet metal forming, Petro-forge forming, Micro forming, Micro coining, Micro extrusion, Micro bending/laser bending, fine blanking.

Unit 2: Advanced Joining Processes **6 Hrs**

Friction stir welding, Electron Beam welding, Laser beam welding, Ultrasonic welding, Under water welding, Cryogenic welding, Thermal spray coatings, Welding of plastics and composites, Explosive joining, Adhesive bonding

Unit 3: Hybrid Non-conventional Machining Techniques **6 Hrs**

Introduction to hybrid processes, Abrasive flow finishing, Magnetic abrasive finishing, Abrasive water-jet machining, Wire electric discharge machining, Electrochemical grinding (ECG), Electrochemical Deburring (ECD), Shaped tube electrolytic machining (STEM), Electro-jet Machining (EJM), Electrolytic In-process dressing (ELPD), Ultrasonic assisted EDM, Rotary EDM, Electrochemical discharge Machining (ECDM), Laser surface treatments.

Unit 4: Micro Machining and Nano Fabrication Techniques **6 Hrs**

Introduction, need of micro and nano machining, Machine/setup, Process parameters, Mechanism of material removal, Applications, Advances of the Diamond Turn machining, Ultrasonic micro-machining, Focused Ion Beam Machining, Lithography, photochemical machining, Challenges in micro and nano fabrication techniques.

Unit 5: Additive Manufacturing Processes **6 Hrs**

Introduction and principle of the additive manufacturing process; Generalized additive manufacturing process chain; Classification of additive manufacturing processes and its principle, process steps and materials;

Post-processing of parts manufactured by Additive Manufacturing (AM) processes, Software issues in AM, Design For Additive Manufacturing (DFAM), Applications of Additive Manufacturing in Medical and Aerospace technologies

Unit 6: Material Characterization Techniques **6 Hrs**

Introduction : Material Characterization

Microscopy : Electron Microscopes, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), Field Ion Microscope (FIM);

Spectroscopy : Energy-dispersive X-ray spectroscopy (EDX), X-Ray Diffraction (XRD), X-Ray Photoelectron Spectroscopy (XPS), Nuclear Magnetic Resonance Spectroscopy (NMR), Electron Backscatter Diffraction (EBSD)

Books

Text :

1. V. K. Jain, “Advanced Machining Processes”, Allied Publishers Pvt. Ltd.
2. M. P Groover., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 6th Edition, Wiley 2015
3. A. Ghosh, A. K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd., New Delhi

References :

1. ASM: Metal Handbook, Volume 6, “Welding, Brazing and Soldering”, Metal Park, Ohio.
2. ASM: Metal Handbook, Volume 14, “Forming”, Metal Park, Ohio.
3. R. Balasubramaniam, RamaGopal V. Sarepaka, SathyanSubbiah, Diamond Turn Machining: Theory and Practice, CRC Press, ISBN 9781138748323 - CAT# K32643
4. V. K. Jain, Micro manufacturing Processes, CRC Press ISBN-13: 978-1138076426 ISBN-

10: 1138076422
5. Ian Gibson, David Rosen, B.Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, And Direct Digital Manufacturing, New York, NY : Springer, 2015.
6. Sam Zhang, Lin Li, Ashok Kumar, Materials characterization techniques. Boca Raton: CRC Press. ISBN 1420042947
7. Douglas B. Murphy, Fundamentals of light microscopy and electronic imaging, 2001, Wiley-Liss, Inc. USA
8. Schwartz, A. J., Kumar, M., Adams, B. L., and Field, D. P., eds., 2009, Electron Backscatter Diffraction in Materials Science, Springer US.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402050 B | **Course Name : Elective – IV Solar and Wind Energy**

Teaching Scheme:		**Credits**		**Examination Scheme:**		
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR : --**
Practical	**: --**	**TW**	**: --**		**End-Sem : 70**	**OR : --**
						TW : --

Pre-requisites	**:** Basic Mechanical Engineering, Basic Electrical and Electronics Engineering and Heat Transfer

Course Objectives:

- To understand fundamentals of solar and wind energies.
- To understand constructions, working principle and design procedure of solar and wind power plants.
- To apply basic engineering principle to design a simple solar and wind power system.

Course Outcomes:

On completion of the course, students will be able to -

- Design of solar food drier for domestic purpose referring existing system
- Design of parabolic dish solar cooker for domestic purpose referring existing system
- Design of solar photovoltaic system for domestic purpose referring existing system
- Design miniature wind mill for domestic purpose referring existing system

Course Contents

Unit 1: Solar Energy Principles **6 Hrs**

Present solar energy scenario, world energy futures, governing bodies (self-study), solar radiations and its measurements, solar constant, solar radiation geometry, solar radiation data, estimation of average solar radiation, solar radiation on tilted surface.

Unit 2: Solar Thermal Systems and Applications **8 Hrs**

Types of Solar thermal collector, flat plate collector analysis, Evacuated tube collectors (ETC) analysis, its design and application, solar air heaters and its types, solar distillation.

Solar Concentrating collectors: types- line and point concentrator, theory of Concentrating collectors, parabolic trough collector, parabolic dish collector, solar tower, concentrated Fresnel linear receiver (CFLR).

Unit 3: Solar Photovoltaic and Applications **6 Hrs**

Forming the PN junction solar cells & its applications, Structure of a solar cell, types of modules, PV array, solar cell equation, Fill factor and maximum power, Grid aspects of solar power, equipment used in solar photovoltaic plants, Power Conditioning Equipment-inverters, Regulators, Other Devices; System Analysis-Design Procedure, Design Constraints, Other Considerations.

Unit 4: Case Study on Solar Energy Applications **6 Hrs**

Case study 1: Design of solar food drier for domestic purpose referring existing system
Case study 2: Design of parabolic dish solar cooker for domestic purpose referring existing system
Case study 3: Design of solar photovoltaic system for domestic purpose referring existing system

Unit 5: Wind Energy **8 Hrs**

Principle of wind energy conversion; Basic components of wind energy conversion systems; various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations, wind energy potential and installation in India.

Unit 6: Case Study on Wind Mill Design **2 Hrs**

Case study on designing miniature wind mill for domestic purpose referring existing system.

Books

Text :

1. G. D. Rai, 'Non-Conventional Energy Sources', Khanna Publisher
2. S. P. Sukhatme, 'Solar Energy: Principles of thermal collections and storage', McGraw Hill
3. Tiwari G N. 'Solar Energy: Fundamentals, design, modeling and Applications', Narosa, 2002

References :

1. Mukund R. Patel, 'Wind And Solar Power Systems: Design, Analysis and Operation, Second Edition', CRC Press
2. Kreith And Kreider, Solar Energy Handbook, McGraw Hill
3. Ray Hunter, 'Wind Energy Conversion: From Theory to Practice', John Wiley and Son Ltd
4. Gary L Johnson, 'Wind Energy Systems', Prentice-Hall Inc., New Jersey
5. Martin O L Hansen, 'Aerodynamics of Wind Turbines', James & James/Earthscan.
6. Goswami D Y, Kreith F, Kreider J F, 'Principles of Solar Engineering', Taylor & Francis
7. Robert Gasch, 'Wind Power Plant Fundamentals, Design, Construction And Operations', Springer
8. C S Solanki, 'Solar Photovoltaic: Fundamentals, Technology And Applications', PHI Learning

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402050 C **Course Name : Elective – IV**

Product Design and Development

Teaching Scheme:		Credits		Examination Scheme:			
Theory	**: 03 Hrs Per Week**	**TH**	**: 03**	**Theory**	**In-Sem : 30**	**PR**	**: --**
Practical	**: --**	**TW**	**: --**		**End-Sem : 70**	**OR**	**: --**
						TW	**: --**

Pre-requisites	**:** Basic Engineering Science - Physics, Chemistry, Material Science, Engineering Metallurgy, Manufacturing processes

Course Objectives:

To explain student's significance of

- Product design and Product development process
- Customer needs, satisfaction and commercialization of product
- Forward & Reverse Engineering and its role in designing a product
- Design Aspects (DFA, DFMEA, Design for Reliability and Safety)
- Product Life Cycle Management and Product Data Management

Course Outcomes:

On completion of the course, students will be able to -

- Understand essential factors for product design
- Design product as per customer needs and satisfaction
- Understand Processes and concepts during product development
- Understand methods and processes of Forward and Reverse engineering
- Carry various design processes as DFA, DFMEA, design for safety
- Understand the product life cycle and product data management

Course Contents

Unit 1: Introduction to Product Design and Development **6 Hrs**

Definition of product design, Essential Factors for product design, Modern approaches to product design, standardization, simplification and specialization in product design product development, product development versus product design, modern product development process, product testing and validation.

Unit 2: Product Development –Technical and Business Concerns **6 Hrs**

Mission Statement and Technical Questioning, Technology Forecasting and S Curve, Customer Needs and Satisfaction, Customer Needs - Types and Models, tools for Gathering Customer Needs, Customer Population and Market Segmentation.

Unit 3: Product Development from Concept to Product Function **6 Hrs**

Product information gathering, brainstorming and lateral thinking, morphological analysis of product, generating concepts, concept selection - design evaluation, estimation of technical feasibility, concept selection process, Pugh's concept, selection charts, concept scoring, process of concept embodiment, system modeling, functional modeling and decomposition, fast method, subtract and operate procedure, Simulation driven design.

Unit 4: Reverse Engineering **6 Hrs**

Product Teardown Process, Tear Down Methods, Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used in Benchmarking Indented Assembly Cost Analysis, Function -Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product Portfolio and Architecture.

Unit 5: Design for X **6 Hrs**

Design for manufacture, Design for assembly, Design for robustness, Design for safety, Design for reliability, Design for environment, Design for piece part production, manufacturing cost analysis. Local, Regional and Global issues, basic life cycle assessment - basic method, weighed sum assessment method (Numerical), Design Failure mode effect analysis.

Unit 6: Product Life Cycle Management and Product Data Management **6 Hrs**

Introduction, Concept of Product Life Cycle management, Components/Elements of PLM, Customer Involvement, Product Data and Product Workflow, The Link Between Product Data and Product Workflow, Different Phases of Product Life Cycle and corresponding technology.

Books

Text :

1. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice Hall India.
2. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000.

References :

1. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education Inc.
2. Grieves, Michael, Product Lifecycle Management McGraw Hill
3. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub.
4. Karl Ulrich, product design and development, TMH.

Savitribai Phule Pune University
Final Year of Mechanical Engineering (2015 Course)

Course Code : 402051 **Course Name : Project – II**

Teaching Scheme:		Credits		Examination Scheme:				
Theory	**: --**	**TH**	**: --**	**Theory**	**In-Sem**	**: --**	**PR**	**: --**
Practical	**: 12 hrs per week**	**TW**	**: 06**		**End-Sem**	**: --**	**OR**	**: 100**
							TW	**: 100**

Course Contents

INSTRUCTIONS FOR PROJECT REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of B.E. (Mechanical Engineering).

1. Prepare ***Three Hard Bound Copies*** of your manuscript.
2. Limit your Dissertation report to *80– 120* pages (preferably)
3. The *footer must include* the following:
   Institute Name, B.E. (Mechanical) Times New Roman 10 pt. and centrally aligned.
4. Page number as second line of footer, Times New Roman 10 pt. centrally aligned.
5. Print the manuscript using
   a) Letter quality computer printing.
   b) The main part of manuscript should be Times New Roman 12 pt. with alignment - justified.
   c) Use 1.5 line spacing.
   d) Entire report shall be of 5- 7 chapters
6. Use the paper size 8.5’’ × 11’’ or A4 (210 × 197 mm). Please follow the margins given below.

Margin Location	Paper 8.5’’ × 11’’	Paper A4 (210 × 197 mm)
Top	1’’	25.4 mm
Left	1.5’’	37 mm
Bottom	1.25’’	32 mm
Right	1’’	25.4mm

7. All paragraphs will be 1.5 lines spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.
8. Section titles should be bold with 14 pt. typed in all capital letters and should be left aligned.
9. Sub-Section headings should be aligning at the left with 12 pt. bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, black and white. Illustrations downloaded from internet are not acceptable.
    a) Illustrations should not be more than two per page. One could be ideal
    b) Figure No. and Title at bottom with 12 pt.
    c) Table No. and Title at top with 12 pt.
    d) Legends below the title in 10 pt.
    e) Leave proper margin in all sides

f) Illustrations as far as possible should not be photo copied.

11. Photographs if any should be of glossy prints
12. Please use SI system of units only.
13. Please number the pages on the front side, centrally below the footer
14. References should be either in order as they appear in the thesis or in alphabetical order by last name of first author
15. Symbols and notations if any should be included in nomenclature section only
16. Following will be the order of report
    i. Cover page and Front page (*as per the specimen on separate sheet*)
    ii. Certificate from the Institute (*as per the specimen on separate sheet*)
    iii. Acknowledgements
    iv. Contents
    v. List of Figures
    vi. List of Tables
    vii. Nomenclature
    viii. Abstract (A brief abstract of the report not more than 150 words. The heading of abstract i.e. word "Abstract" should be bold, Times New Roman, 12 pt and should be typed at the center. The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on motive, method, key-results and conclusions in Abstract

    1. Introduction (2-3 pages) (TNR – 14 Bold)
        1.1 Problem statement (TNR – 12)
        1.2 Objectives
        1.3 Scope
        1.4 Methodology
        1.5 Organization of Dissertation

    2. Literature Review (20-30 pages)
    Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.

    3. This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (15- 20 pages)

    4. Experimental Validation - This chapter shall be based on your own experimental work (15-20 pages)

    5. Concluding Remarks and Scope for the Future Work (2-3 pages)
    References ANNEXURE (if any) (Put all mathematical derivations, Simulation program as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers 1, 2, 3, … and for subheadings 1.1, 1.2, …. etc and section subheadings 2.1.1, 2.1.2, …. etc.
18. References should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If figures and tables are taken from any reference then indicate source / citation of it. Please follow the following procedure for references

    Reference Books :

    Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford

University Press, UK, 1996, pp. 110 – 112.

<u>*Papers from Journal or Transactions*</u> :
Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.
Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

<u>*Papers from Conference Proceedings*</u> :
Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

<u>*Reports, Handbooks etc.*</u> :
United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.
ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

<u>*Patent*</u> :
Patent no, Country (in parenthesis), date of application, title, year.

<u>*Internet*</u> :
www.(Site) [Give full length URL] *accessed on date*

A Project Report on
(TNR, 16pt, centrally aligned)

Title of the Project Report

(TNR, 27pt, Bold, Centrally Aligned, Title Case)

By
(TNR, 16pt, Centrally Aligned)

Mr. Student's 1 Name
(TNR, 16pt, Centrally Aligned)

Mr. Student's 2 Name
(TNR, 16pt, Centrally Aligned)

Mr. Student's 3 Name
(TNR, 16pt, Centrally Aligned)

Mr. Student's 4 Name
(TNR, 16pt, Centrally Aligned)

Guide
Guide's Name
(TNR, 16pt, Centrally Aligned)

Institute Logo

Department of Mechanical Engineering
Name of the Institute
[2018-19]
(TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute Logo

C E R T I F I C A T E

This is to certify that ***Mr. (Name of the Student)***, has successfully completed the Project Stage – I entitled "(***Title of the Project)***" under my supervision, in the partial fulfillment of Bachelor of Engineering - Mechanical Engineering of University of Pune.

Date:

Place:

Guide's Name
Guide

Internal Examiner

HoD Name
Head of the Department

Principal Name
Principal

External Examiner

Seal