

# **Faculty of Engineering Savitribai Phule Pune University, Pune**



## **Syllabus**

### **Master of Computer Engineering (Course 2017)**

**(with effect from Year 2017-18 )**

## Prologue

It is with great pleasure and honor that I present the syllabus for Master of Computer Engineering (2017 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.

While revising syllabus, honest and sincere efforts are put to tune curriculum for post graduate program in Computer Engineering in tandem with the objectives of Higher Education of India, AICTE, UGC and affiliated University- Savitribai Phule Pune University (SPPU) by keeping an eye on the technological advancements and industrial requirements globally.

The basic motives of designing the contents of various courses is to focus on independent learning convergence to special domains, development of research attitude and comprehensive coverage of technologies. Elective courses with choice for module selection provide flexibility and opportunity to explore the domain specific knowledge.

The open elective is to invite the attention to multidisciplinary, interdisciplinary, exotic, employability or update to technology course. The institute may design the syllabus accordingly. However such designed syllabus needs to be approved by SPPU authority before implementation.

While framing each course contents, Course advisor, Course Coordinators and Team Members have put arduous efforts in meeting the standards of the Courses at PG level. Everybody in the team has meticulously stuck to the guidelines and recommendations to materialize the team efforts. The fruition is only due to sincere efforts, active participation, expert opinions and suggestions from domain professionals.

I am sincerely indebted to all the minds and hands who work dexterously and synchronously to materialize the huge task.

Thanks.

**Dr. Varsha H. Patil**

**Coordinator, Board of Studies (Computer Engineering), SPPU, Pune**

**Tuesday, March 28, 2017. Mail-id: [yh\\_patil2003@yahoo.com](mailto:yh_patil2003@yahoo.com)**

[This document includes Program Educational Objectives - Program Outcomes, Program Specific Outcomes (page 3-4), Semester-wise Courses (teaching scheme, examination, marks and credit) (page 5-6), Courses syllabi (page 7-63)] and Non Credit Course Contents [64-70].

## Program Educational Objectives

- PEO1:** To prepare globally competent post graduates with enhanced domain knowledge and skills attaining professional excellence and updated with modern technology to provide effective solutions for engineering and research problems.
- PEO2:** To prepare the post graduates to work as a committed professionals with strong professional ethics and values, sense of responsibilities, understanding of legal, safety, health, societal, cultural and environmental issues.
- PEO3:** To prepare motivated post graduates with research attitude, lifelong learning, investigative approach, and multidisciplinary thinking to succeed in the career in industry/academia/research
- PEO4:** To prepare post graduates with strong managerial and communication skills to work effectively as an individual as well as in teams.

## Program Outcomes

**Students are expected to know and be able –**

### **PO1: Scholarship of Knowledge**

Acquire in-depth knowledge of Computer Science and Engineering, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

### **PO2: Critical Thinking**

Analyze complex engineering problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

### **PO3: Problem Solving**

Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

### **PO4: Research Skills**

Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

### **PO5: Usage of Modern Tools**

Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

### **PO6: Collaborative and Multidisciplinary work**

Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness,

objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

**PO7: Project Management and Finance**

Demonstrate knowledge and understanding of Computer Science & Engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

**PO8: Communication**

Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

**PO9: Life-long Learning**

Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

**PO10: Ethical Practices and Social Responsibility**

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

**PO11: Independent and Reflective Learning**

Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

### Program Specific Outcomes (PSO)

**A post graduate of the Computer Engineering Program will demonstrate-**

**PSO1: Professional Skills**

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

**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, with zest for research.

**PSO4: Research Skills**

The ability to study, experiment, interpret, analyze and explore the solutions to the engineering problems which are effective, efficient, optimized and feasible.

**Savitribai Phule Pune University, Pune**  
**Master of Computer Engineering (2017 Course)**  
 (with effect from June 2017)

**Semester I**

| Course Code | Course   | Teaching Scheme<br>Hours / Week |           | Examination Scheme and Marks |                                 |    |         |       | Credit |    |
|-------------|--|---------------------------------|-----------|------------------------------|---------------------------------|----|---------|-------|--------|----|
|             |  | Theory                          | Practical | In-Sem                       | End-Sem                         | TW | OR/ PRE | Total | TH     | PR |
| 510101      | <a href="#">Research Methodology</a>                     | 04                              | --        | 50                           | 50                              | -- | --      | 100   | 04     | -- |
| 510102      | <a href="#">Bio-Inspired Optimization Algorithms</a>     | 04                              | --        | 50                           | 50                              | -- | --      | 100   | 04     | -- |
| 510103      | <a href="#">Software Development and Version Control</a> | 04                              | --        | 50                           | 50                              | -- | --      | 100   | 04     | -- |
| 510104      | <a href="#">Embedded and Real Time Operating Systems</a> | 04                              | --        | 50                           | 50                              | -- | --      | 100   | 04     | -- |
| 510105      | <a href="#">Elective I</a>                               | 05                              | --        | 50                           | 50                              | -- | --      | 100   | 05     | -  |
| 510106      | <a href="#">Laboratory Proficiency I</a>                 | --                              | 08        | --                           | --                              | 50 | 50      | 100   | --     | 04 |
|             | Total Credit   |                                 |           |                              |                                 |    |         | 21    | 04     |    |
| Total       |  | 21                              | 08        | 250                          | 250                             | 50 | 50      | 600   | 25     |    |
| 510107      | <a href="#">Non-Credit Course I</a>                      |                                 |           |                              |                                 |    |         |       | Grade  |    |
| Elective I  |  |                                 |           |                              |                                 |    |         |       |        |    |
| 510105A     | <a href="#">Advanced Digital Signal Processing</a>       |                                 |           | 510105B                      | <a href="#">Data Mining</a>     |    |         |       |        |    |
| 510105C     | <a href="#">Network Design and Analysis</a>              |                                 |           | 510105D                      | <a href="#">Data Algorithms</a> |    |         |       |        |    |
| 510105E     | Open Elective  |                                 |           |                              |                                 |    |         |       |        |    |

**Semester II**

| Course Code | Course   | Teaching Scheme<br>Hours / Week |           | Examination Scheme and Marks |         |                                  |            |       | Credit |    |
|-------------|--|---------------------------------|-----------|------------------------------|---------|----------------------------------|------------|-------|--------|----|
|             |  | Theory                          | Practical | In-Sem                       | End-Sem | TW                               | OR/<br>PRE | Total | TH     | PR |
| 510108      | <a href="#">Operations Research</a>                | 04                              | --        | 50                           | 50      | --                               | --         | 100   | 04     | -- |
| 510109      | <a href="#">System Simulation and Modeling</a>     | 04                              | --        | 50                           | 50      | --                               | --         | 100   | 04     | -- |
| 510110      | <a href="#">Machine Learning</a>                   | 04                              | --        | 50                           | 50      | --                               | --         | 100   | 04     | -- |
| 510111      | <a href="#">Elective II</a>                        | 05                              | --        | 50                           | 50      | --                               | --         | 100   | 05     | -- |
| 510112      | <a href="#">Seminar I</a>                          |                                 | 04        | --                           | --      | 50                               | 50         | 100   | --     | 04 |
| 510113      | <a href="#">Laboratory Proficiency II</a>          | --                              | 08        | --                           | --      | 50                               | 50         | 100   | --     | 04 |
|             | Total Credit                                       |                                 |           |                              |         |                                  |            |       | 17     | 08 |
| Total       |  | 17                              | 12        | 200                          | 200     | 100                              | 100        | 600   | 25     |    |
| 510114      | <a href="#">Non-Credit Course II</a>               |                                 |           |                              |         |                                  |            |       | Grade  |    |
| Elective II |  |                                 |           |                              |         |                                  |            |       |        |    |
| 510111A     | <a href="#">Image Processing</a>                   |                                 |           | 510111B                      |         | <a href="#">Web Mining</a>       |            |       |        |    |
| 510111C     | <a href="#">Pervasive and Ubiquitous Computing</a> |                                 |           | 510111D                      |         | <a href="#">Network Security</a> |            |       |        |    |
| 510111E     | Open Elective                                      |                                 |           |                              |         |                                  |            |       |        |    |

**Abbreviations:** TW: Term Work , TH: Theory, OR: Oral, PRE: Presentation, Sem: Semester

| Savitribai Phule Pune University, Pune  |  |                              |  |                                    |         |               |        |       |        |    |
|---|--|------------------------------|--|------------------------------------|---------|---------------|--------|-------|--------|----|
| Master of Computer Engineering (2017 Course)  |  |                              |  |                                    |         |               |        |       |        |    |
| <u>Semester III</u>   |  |                              |  |                                    |         |               |        |       |        |    |
| Course Code   | Course                                 | Teaching Scheme Hours / Week |  | Examination Scheme and Marks       |         |               |        |       | Credit |    |
|   |  | Theory                       | Practical                                | In-Sem                             | End-Sem | TW            | OR/PRE | Total | TH     | PR |
| 610101  | <a href="#">Fault Tolerant Systems</a> | 04                           | --                                       | 50                                 | 50      | --            | --     | 100   | 04     | -- |
| 610102  | <a href="#">Information Retrieval</a>  | 04                           | --                                       | 50                                 | 50      | --            | --     | 100   | 04     | -- |
| 610103  | <a href="#">Elective III</a>           | 05                           | --                                       | 50                                 | 50      | --            | --     | 100   | 05     | -- |
| 610104  | <a href="#">Seminar II</a>             | --                           | 04                                       | --                                 | --      | 50            | 50     | 100   | --     | 04 |
| 610105  | <a href="#">Dissertation Stage I</a>   | --                           | 08                                       | --                                 | --      | 50            | 50     | 100   | --     | 08 |
| Total Credit  |  |                              |  |                                    |         |               |        |       | 13     | 12 |
| Total   |  | 13                           | 12                                       | 150                                | 150     | 100           | 100    | 500   | 25     |    |
| 610106  | <a href="#">Non-Credit Course III</a>  |                              |  |                                    |         |               |        |       | Grade  |    |
| <u>Elective III</u>   |  |                              |  |                                    |         |               |        |       |        |    |
| 610103A   | <a href="#">Cloud Security</a>         | 610103B                      | <a href="#">Speech Signal Processing</a> |                                    |         |               |        |       |        |    |
| 610103C   | <a href="#">Mobile Ad-hoc Network</a>  | 610103D                      | <a href="#">Pattern Recognition</a>      | 610103E                            |         | Open Elective |        |       |        |    |
| <u>Semester IV</u>  |  |                              |  |                                    |         |               |        |       |        |    |
| Course Code   | Course                                 | Teaching Scheme Hours / Week |  | Examination Scheme and Marks       |         |               | Credit |       |        |    |
|   |  | Practical                    |  | TW                                 | OR/PRE  | Total         | PR     |       |        |    |
| 610107  | <a href="#">Seminar III</a>            | 05                           |  | 50                                 | 50      | 100           | 05     |       |        |    |
| 610108  | <a href="#">Dissertation Stage II</a>  | 20                           |  | 150                                | 50      | 200           | 20     |       |        |    |
| Total   |  | 25                           |  | 200                                | 100     | 300           | 25     |       |        |    |
| <u>Non-Credit Courses</u>   |  |                              |  |                                    |         |               |        |       |        |    |
| Typically curriculum is constituted by credit, non-credit and audit courses. These courses are offered as compulsory or elective. Non Credit Courses are compulsory. No grade points are associated with non-credit courses and are not accounted in the calculation of the performance indices SGPA & CGPA. However, the award of the degree is subject to obtain a PP grade for non credit courses. Conduction and assessment of performance in said course is to be done at institute level. The mode of the conduction and assessment can be decided by respective course instructor. Recommended but not limited to- (one or combination of) seminar, workshop, MOOC Course certification, mini project, lab assignments, lab/oral/written examination, field visit, field training. Examinee should submit report/journal of the same. Reports and documents of conduction and assessment in appropriate format are to be maintained at institute. <u>Result of assessment will be PP or NP.</u> Set of non-credit courses offered is provided. The Examinee has to select the relevant course from pool of courses offered. Course Instructor may offer beyond this list by seeking recommendation from SPPU authority. The selection of 3 distinct non-credit courses, one per semester (Semester I, II & III). The <a href="#">Contents of Non Credit Courses</a> are Provided at page 63 onwards. |  |                              |  |                                    |         |               |        |       |        |    |
| <u>Open Elective:</u> The open elective is to invite the attention to multidisciplinary, interdisciplinary, exotic, employability or update to technology course. The institute may design the syllabus accordingly. However such designed syllabus needs to be approved by SPPU authority before implementation.   |  |                              |  |                                    |         |               |        |       |        |    |
| <b><u>Recommended Set of Non-Credit Courses(510107, 510114, 610106):</u></b>  |  |                              |  |                                    |         |               |        |       |        |    |
| NCC1: <a href="#">Game Engineering</a>  |  |                              |  | NCC2: Advanced Cognitive Computing |         |               |        |       |        |    |
| NCC3: Reconfigurable Systems  |  |                              |  | NCC4: Convergence Technology       |         |               |        |       |        |    |
| NCC5: Machine Learning  |  |                              |  | NCC6: Storage Area Networks        |         |               |        |       |        |    |
| NCC7: Search Engine Optimization  |  |                              |  | NCC8: Virtual Reality              |         |               |        |       |        |    |
| NCC9: Machine Translation   |  |                              |  | NCC10: Infrastructure Management   |         |               |        |       |        |    |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510101: Research Methodology</b>   |   |   |
|---|---|---|
| <b>Teaching Scheme:</b><br><b>TH: 04 Hours/Week</b>   | <b>Credit</b><br><b>04</b>                                    | <b>Examination Scheme:</b><br><b>In-Sem : 50 Marks</b><br><b>End-Sem : 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To understand the philosophy of research in general</li> <li>To understand basic concepts of research and its methodologies</li> <li>To learn the methodology to conduct the Literature Survey</li> <li>To acquaint with the tools, techniques, and processes of doing research</li> <li>To learn the effective report writing skills and allied documentations</li> <li>To become aware of the ethics in research, academic integrity and plagiarism</li> </ul>  |   |   |
| <b>Course Outcomes:</b><br>After completion of the course, students should be able to <ul style="list-style-type: none"> <li>Carry out Literature Survey</li> <li>Identify appropriate topics for research work in computer engineering</li> <li>Select and define appropriate research problem and parameters</li> <li>Design the use of major experimental methods for research</li> <li>Use appropriate tools, techniques, and processes of doing research in Computer science</li> <li>Demonstrate own contribution to the body of knowledge</li> <li>Become aware of the ethics in research, academic integrity and plagiarism</li> <li>Write a research report and thesis</li> </ul>  |   |   |
| <b>Course Contents</b>  |   |   |
| <b>Unit I</b>   | <b>Introduction</b>   | <b>08 Hours</b>   |
| <b>Evolution of Research Methodology:</b> Meaning, nature, scope, and significance of research; Research paradigm; The purpose and outcomes of Research; Objectives of research, Motivation for research; Postulates underlying scientific investigations; Types of research; Research process and work flow.<br><b>Engineering Research-Why?</b> Research Questions, Engineering Ethics, conclusive proof-what constitutes, A research project-Why take on?<br><b>Case Study-</b> Code of Ethics, IEEE Code of Ethics, ACM Software Engineering Code of Ethics and Professional Practice, Code of Ethics especially covering Engineering discipline, various aspects-environment, sustainable outcomes, employer, general public, and Nation, Engineering Disasters. |   |   |
| <b>Unit II</b>  | <b>Literature Search and Review, Developing Research Plan</b> | <b>08 Hours</b>   |
| Archival Literature, Why should engineers be ethical? Types of publications- Journal papers, conference papers, books, standards, patents, theses, trade magazine, newspaper article, infomercials, advertisement, Wikipedia & websites, Measures of research impact, Literature review, publication cost.<br><b>Case Study- Engineering</b> dictionary, Shodhganga, The Library of Congress, Research gate, Google Scholar, Bibliometrics, Citations, Impact Factor, h-index, I-index, plagiarism, copyright infringement.<br><b>Developing Research Plan:</b> Research Proposals, Finding a suitable research questions, The  |   |   |



elements of research proposals-title, details, budget, Design for outcomes-1D data, 2D data, 3D data, N-D data, The research tools- Experimental measurements, numerical modeling, theoretical derivations & Calculations, curve matching.

**Case Study-** Various Research grants and funding resources

|   |                                |                 |
|---|--------------------------------|-----------------|
| <b>Unit III</b>   | <b>Statistical Analysis</b>    | <b>08 Hours</b> |
| <b>Statistical Analysis:</b> Introduction, Sources of error and uncertainty, One-Dimensional Statistics: combining errors and uncertainties, t-test, ANOVA statistics, example, Two-Dimensional Statistics: example, Multi-Dimensional Statistics: partial correlation coefficients, example, Null hypothesis testing. <b>Case Study-</b> GNU PSPP Tool, SOFA, NOST-Dataplot  |                                |                 |
| <b>Unit IV</b>  | <b>Optimization Techniques</b> | <b>08 Hours</b> |
| <b>Optimization Techniques:</b> Introduction, Two-parameter optimization methods: sequential uniform sampling, Monte Carlo optimization, Simplex Optimization method, Gradient Optimization method, Multi-parameter optimization methods, The cost function.<br><b>Case Study-</b> Google Optimization Tools, OpenMDAO  |                                |                 |
| <b>Unit V</b>   | <b>Survey Research Methods</b> | <b>08 Hours</b> |
| <b>Survey Research Methods:</b> Why undertake a survey, Ergonomics and human factors, Ethics approval, General survey guidelines, Survey statements, Survey delivery, Respondent selection, Survey timelines, Statistical analysis, Reporting.<br><b>Case Study-</b> Qualitative Analysis Tools- AQUAD, CAT   |                                |                 |
| <b>Unit VI</b>  | <b>Research Presentation</b>   | <b>08 Hours</b> |
| <b>Research presentation:</b> Introduction, Standard terms, Standard research methods and experimental techniques, Paper title and keywords, Writing an abstract, Paper presentation and review, Conference presentations, Poster presentations, IPR, Copyright, Patents.<br><b>Reporting Research:</b> Thesis, Structure and Style for writing thesis, Dissemination of research findings; Reporting and interpretation of results; cautions in interpretations, Type of reports, Typical report outlines.<br><b>The path forward:</b> Publication trends, Getting started in research, Quality assurance (QA) Occupational health and safety.<br><b>Case Study:</b> Intellectual Property India- services, InPASS - Indian Patent Advanced Search System, US patent, IEEE / ACM Paper templates.<br><b>A glimpse into the future of Engineering Research.</b> |                                |                 |
| <b>Books:</b>   |                                |                 |
| <b>Text:</b>  |                                |                 |
| 1. David V Thiel, "Research Methods- for Engineers", Cambridge University Press, ISBN:978-1-107-61019-4<br>2. Kothari C.R., "Research Methodology. New Age International, 2004, 2 <sup>nd</sup> Ed; ISBN:13: 978-81-224-1522-3.   |                                |                 |
| <b>References:</b>  |                                |                 |
| 1. Caroline Whitbeck, "Ethics in Engineering Practice and Research", 2 <sup>nd</sup> Ed., Cambridge University Press; ISBN :978-1-107-66847-8<br>2. Gordana DODIG-CRNKOVIC, "Scientific Methods in Computer Science", Department of Computer Science Malardalen University, Vasteas, Sweden; ISBN: 91-26-97860-1  |                                |                 |



| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510102 : Bio-Inspired Optimization Algorithms</b>   |                               |   |
|--|-------------------------------|---|
| <b>Teaching Scheme:</b><br><b>TH: 04 Hours/Week</b>  | <b>Credit</b><br><b>04</b>    | <b>Examination Scheme :</b><br><b>In-Sem: 50 Marks</b><br><b>End-Sem : 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To learn how natural and biological systems influence computational field</li> <li>To understand the strengths and weaknesses of nature-inspired algorithms</li> <li>To learn the functionalities of various Bio-inspired optimization algorithms</li> </ul>                         |                               |   |
| <b>Course Outcomes:</b><br>On completion of the course, student will be able to– <ul style="list-style-type: none"> <li>Describe the natural phenomena that motivate the algorithms</li> <li>Apply nature-inspired algorithms to optimization</li> <li>Select the appropriate strategy or optimal solution based on bio-inspired algorithms</li> </ul> |                               |   |
| <b>Course Contents</b>   |                               |   |
| <b>Unit I</b>  | <b>Natural Computing</b>      | <b>08 Hours</b>   |
| From nature to natural computing, sample idea, Philosophy of natural computing, Natural computing approaches, Conceptualization – general concept, Problem solving as a search track, Hill climbing, Simulated annealing   |                               |   |
| <b>Unit II</b>   | <b>Evolutionary Computing</b> | <b>08 Hours</b>   |
| Evolutionary computing : Evolutionary biology, Evolutionary computing – standard evolutionary algorithm; Genetic algorithm, evolutionary strategies, Evolutionary programming  |                               |   |
| <b>Unit III</b>  | <b>Swarm Intelligence</b>     | <b>08 Hours</b>   |
| Swarm intelligence-biological motivation, from natural to artificial, standard algorithm of Ant colony optimization, Ant clustering algorithm, Particle swarm optimization   |                               |   |
| <b>Unit IV</b>   | <b>Biological Motivation</b>  | <b>08 Hours</b>   |
| Biological motivation, from natural to artificial, standard algorithm of cuckoo search, bat algorithm, flower pollination, firefly algorithm, framework for self tuning algorithms - case study of firefly algorithm   |                               |   |
| <b>Unit V</b>  | <b>Immune Systems</b>         | <b>08 Hours</b>   |
| Immune system, Artificial immune systems - biological motivation, Design principles, main types of algorithms - Bone marrow, Negative selection, Clonal selection, Continuous immune network models, Discrete immune network models, Scope of artificial immune systems  |                               |   |
| <b>Unit VI</b>   | <b>Artificial Life</b>        | <b>08 Hours</b>   |
| The essence of life, Examples of ALife projects- flocks, herds and schools, computer viruses, synthesizing emotional behavior, AIBO robot, Turtles, termites, and traffic jams, framsticks, Scope of artificial life, Current trends and open problems.  |                               |   |
| <b>Books:</b>  |                               |   |
| <b>Text:</b> <ol style="list-style-type: none"> <li>L. N. de Castro, “Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications”, 2006, CRC Press, ISBN-13: 978-1584886433</li> </ol>  |                               |   |

2. D. Floreano and C. Mattiussi, “ Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies”, 2008, MIT Press, ISBN-13: 978-0262062718

**References:**

1. Sam Jones (Editor), “Bio Inspired Computing-Recent Innovations and Applications”, Clanrye International; 2 edition (2 January 2015), ISBN-10: 1632400812
2. Yang Xiao (Editor), “Bio-Inspired Computing and Networking”, CRC Press,
3. “Machine Nature: The Coming Age of Bio-Inspired Computing”, New York: McGraw-Hill, 2002)
4. Adries Engelbrecht, “ Computational Intelligence”, Wiley, ISBN:978-0-470-03561-0
5. D.Floreano and C. Mattiussi, “Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies”, 2008, MIT Press, ISBN-13: 978-0262062718
6. Russell C. Eberhart , Yuhui Shi , James Kennedy, “ Swarm Intelligence: The Morgan Kaufmann Series in Evolutionary Computation”, 1st Edition, ISBN-13: 978-1558605954
7. M. Goodrich, Tamassia, “Algorithm Design & Applications”, Wiley, ISBN:978-1-118-33591-8

**Savitribai Phule Pune University**  
**Master of Computer Engineering (2017 Course)**  
**510103 : Software Development and Version Control**

**Teaching Scheme:**  
**TH: 04 Hours/Week**

**Credit**  
**04**

**Examination Scheme:**  
**In-Sem: 50 Marks**  
**End-Sem : 50 Marks**

**Course Objectives:**

- To enable students to understand software design issues
- To understand software architectures and patterns
- To acquaint software solutions to engineering Problems.
- To learn the significance of Version Control.
- To know and utilize version controls.

**Course Outcomes:**

After completion of the course, students should be able to

- Select and apply the design patterns to software development.
- Design software for real engineering Problems.
- Demonstrate team work for development of software in collaborative environment.
- Use of open source version control tool.

**Course Contents**

| <b>Unit I</b>   | <b>Software Development</b>              | <b>08 Hours</b> |
|---|--|-----------------|
| <p>Design in the software development process, quality attributes of the design product, describing the design solution, design representations, design processes and design strategies. Design practices- incremental, object based and component based.</p> <p><b>Case study</b> – Software design of a Social Networking site like Linkedin, Twitter, Facebook.</p>  |  |                 |
| <b>Unit II</b>  | <b>Software Architecture Design</b>      | <b>08 Hours</b> |
| <p>Models of Software architecture design, Data centered architecture, Hierarchical architecture, Distributed architecture, heterogeneous architecture, product line architecture, product line engineering, and software technology for systematic reuse.</p> <p><b>Case study</b> – Software architecture of a Mobile Robot System (with specific focus on External sensors and actuators, Real-time responsiveness, Acquire sensor Input, control motion and plan future paths).</p> |  |                 |
| <b>Unit III</b>   | <b>Software Architecture Quality</b>     | <b>08 Hours</b> |
| <p>Software Architecture - quality attributes, architecture in agile projects, documenting software architectures, architecture implementation and testing, architecture reconstruction and conformance.</p> <p><b>Case study</b> – Architecting in cloud environment for multi-tenancy.</p>  |  |                 |
| <b>Unit IV</b>  | <b>Software Configuration Management</b> | <b>08 Hours</b> |
| <p>Software Configuration Management - Scope of SCM, source code management core concepts,</p>  |  |                 |

Build Engineering core concepts, Build tools evaluation and selection, Environment configuration control - goals, principles and importance, release management, deployment, configuration management-driven development, compliance, standards and frameworks for configuration management.

**Case study** – Case Study of Improving Quality of Processes by System Virtualization

|               |                                 |                 |
|---------------|---------------------------------|-----------------|
| <b>Unit V</b> | <b>Software Version Control</b> | <b>08 Hours</b> |
|---------------|---------------------------------|-----------------|

Software Version Control -Introduction, Version control types, centralized & Distributed, Centralized Version Control - Basics, Subversion Distributed Version Control - Basics, Advantages, Weaknesses,

**Case Study** : Version Control Best Practices on Git (for Management of Files)

|                |                                       |                 |
|----------------|---------------------------------------|-----------------|
| <b>Unit VI</b> | <b>Software Version Control Tools</b> | <b>08 Hours</b> |
|----------------|---------------------------------------|-----------------|

Software Version Control tools - Basic introduction to open source version control tools like GIT, GitHub, CVS, Apache Subversion, SVN, Mercurial, Bazaar.

Case Study - Setup of a version control tool like Git with understanding Basic configuration, Commits, Branching, Merging, Naming, History.

**Case Study** - Setup of a version control tool like Git with understanding Basic configuration, Commits, Branching, Merging, Naming, History

#### **Books :**

#### **Text:**

1. David Budgen, “Software Design” , Pearson - 2nd Edition, ISBN13: 9780201722192
2. Bob Aiello, Leslie Sachs, “Configuration Management Best Practices: Practical Methods that work in the real world “, Addison Wesley Professional (2010)
3. Eric Sink, “Version Control by Example”, Pyrenean Gold Press, ISBN13: 9780983507901

#### **Reference :**

1. Ian Gorton, “Essential Software Architecture”, Springer, ISBN 13: 9783642191763.
1. Jorge Luis Ortega-Arjona, “Patterns for Parallel Software Design”, Wiley Series, ISBNB:978-0-470-69734-4
2. Kai Qian et al., “ Software Architecture and Design Illuminated”, Jones and Bartlett Publishers International, ISBN 13: 9780763754204.
3. Len Bass, Paul Clements, Rick Kazman, “Software architecture in practice” , 3rd edition, Addison Wesley, ISBN 13: 9780321815736
4. Ben Collins-Sussman, Brian William Fitzpatrick, C. Michael Pilato, “Version Control with Subversion” , O'Reilly Media , ISBN 13: 9781440495878
5. Scott Chacon and Ben Straub, “ Pro Git”, Apress, ISBN 13: 9781484200766
6. Richard E. Silverman, “ Git Pocket Guide: A Working Introduction”, O'Reilly Media, ISBN13: 9781449325862
7. 828-2012 - IEEE Standard for Configuration Management in Systems and Software Engineering
8. Software Engineering Competency Model Version 1.0 SWECOM by IEEE computer society

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510104 : Embedded and Real Time Operating Systems</b>  |                                      |  |
|---|--------------------------------------|--|
| <b>Teaching Scheme:</b><br><b>TH: 04 Hours/Week</b>   | <b>Credit</b><br><b>04</b>           | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem : 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To understand embedded system, its constituents and the selection process of processor and memory for the embedded systems</li> <li>To learn communication buses and protocols used in the embedded and real-time systems</li> <li>To understand real-time operating system (RTOS), types of RTOS, temporal, functional and resource parameters of an RTOS process</li> <li>To learn various approaches to real-time scheduling and scheduling algorithms and multiprocessor scheduling</li> <li>To understand resource access control and inter-process communication for RTOS tasks</li> <li>To understand software development process, tools and debugging for RTOS applications</li> <li>To learn designing of RTOS based applications</li> </ul> |                                      |  |
| <b>Course Outcomes:</b><br>On completion of the course, student will be able to– <ul style="list-style-type: none"> <li>Recognize and classify embedded and real-time systems</li> <li>Explain communication bus protocols used for embedded and real-time systems</li> <li>Classify and exemplify scheduling algorithms</li> <li>Apply software development process to a given RTOS application</li> <li>Design a given RTOS based application</li> </ul>  |                                      |  |
| <b>Course Contents</b>  |                                      |  |
| <b>Unit I</b>   | <b>Embedded Systems</b>              | <b>08 Hours</b>  |
| Introduction to Embedded systems, Characteristics, Challenges, Processors in Embedded systems, hardware Units 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   |                                      |  |
| <b>Unit II</b>  | <b>Embedded System On Chip (SOC)</b> | <b>08 Hours</b>  |
| 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<br>Networked embedded systems- I2C, CAN, USB, Fire wire. Internet enabled systems- TCP, IP, UDP. Wireless and mobile system Protocols- IrDA, Bluetooth, 802.11, ZigBee   |                                      |  |
| <b>Unit III</b>   | <b>I/O Communication</b>             | <b>08 Hours</b>  |
| 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.  |                                      |  |

|   |                                    |                 |
|---|------------------------------------|-----------------|
| Case Study: Wireless and mobile system Protocols- IrDA, Bluetooth, 802.11, ZigBee   |                                    |                 |
| <b>Unit IV</b>  | <b>Real Time Operating System</b>  | <b>08 Hours</b> |
| <p>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</p> <p>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 aperiodic and sporadic real-time tasks</p> |                                    |                 |
| <b>Unit V</b>   | <b>Inter-process communication</b> | <b>08 Hours</b> |
| <p>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.</p> <p>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</p>   |                                    |                 |
| <b>Unit VI</b>  | <b>Multiprocessor Scheduling</b>   | <b>08 Hours</b> |
| <p>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.</p> <p>Real-time operating systems: Capabilities of commercial real-time operating systems, QNX/Neutrino, Microc/OS-II, VxWorks, Windows CE and RTLinux</p>  |                                    |                 |
| <b>Books:</b>   |                                    |                 |
| <b>Text :</b>   |                                    |                 |
| <ol style="list-style-type: none"> <li>1. Raj Kamal, “Embedded Systems: Architecture, programming and Design”, 2<sup>nd</sup> Edition, McGraw-Hill, ISBN: 13: 9780070151253</li> <li>2. Jane W. S. Liu, “Real-Time Systems”, Pearson Education, ISBN: 10: 0130996513</li> <li>3. David E. Simon, “An Embedded Software Primer”, Pearson Education, ISBN: :8177581546</li> </ol>   |                                    |                 |
| <b>References:</b>  |                                    |                 |
| <ol style="list-style-type: none"> <li>1. Sriram V. Iyer, Pankaj Gupta, “Embedded Real-time Systems Programming”, Tata McGraw-Hill, ISBN: 13: 9780070482845</li> <li>2. Dr. K. V. K. K. Prasad, “Embedded Real-Time Systems: Concepts: Design and Programming”, Black Book, Dreamtech Press, ISBN: 10: 8177224611, 13: 9788177224610</li> </ol>   |                                    |                 |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective I</b><br><b>510105A : Advanced Digital Signal Processing</b>  |                                  |  |
|---|----------------------------------|--|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>   | <b>Credits</b><br><b>05</b>      | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem : 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To learn theory behind signal processing</li> <li>To Understand mathematics of signal processing</li> <li>To know the significance and use of filters</li> <li>To explore the applications DSP</li> </ul>  |                                  |  |
| <b>Course Outcomes:</b><br>After completion of the course, students should be able to- <ul style="list-style-type: none"> <li>Apply various transforms for Digital signal Processing</li> <li>Use appropriate filters to suit to the DSP application</li> <li>Choose the best DS Processor for the application development</li> <li>Design the DSP application for the practical use</li> </ul> |                                  |  |
| <b>Selection of Modules:</b><br>Kindly note that modules 1, 2 are compulsory and select any three (03) modules from module number-3 to 7.   |                                  |  |
| <b>Course Contents</b>  |                                  |  |
| <b>Module No</b>  | <b>Module Title</b>              | <b>Credit</b>  |
| <b>1</b>  | <b>DSP Preliminaries</b>         | <b>01</b>  |
| Signals, Systems, and Signal Processing, Classification of Signals, Sampling of Analog Signals, The Sampling Theorem, Response of LTI Systems to Arbitrary Inputs: The Convolution Sum, Causal Linear Time-Invariant Systems, Stability of Linear Time-Invariant Systems, System with Finite-Duration and Infinite-Duration Impulse.  |                                  |  |
| <b>2</b>  | <b>Transforms</b>                | <b>01</b>  |
| Efficient Computation of the DFT: FFT Algorithms, The Z-Transform, Properties of Z-Transform, Overview of Real World Applications of DSP, Audio Applications of DSP.  |                                  |  |
| <b>3</b>  | <b>FIR Filter Design</b>         | <b>01</b>  |
| Introduction, FIR Filter Design, FIR Filter Specifications, FIR Coefficient Calculation Methods, Window Method, Direct-Form Structure, Cascade-Form Structures, Finite word length effects in FIR Digital Filters.  |                                  |  |
| <b>4</b>  | <b>IIR Filter Design</b>         | <b>01</b>  |
| IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation, Characteristics of Commonly Used Analog Filters, Design of IIR Filter From Analog Filter, Direct-Form Structures, Cascade-Form Structures, Parallel-Form Structures.  |                                  |  |
| <b>5</b>  | <b>Power Spectrum Estimation</b> | <b>01</b>  |



|  |   |           |
|--|---|-----------|
| Estimation of Spectra From Finite-Duration Observations of Signals, Nonparametric Methods for Power Spectrum Estimation, Relationships Between Autocorrelation and the Model Parameters, The Yule-Walker Method for the AR Model Parameters.   |   |           |
| <b>6</b>   | <b>Multi rate Signal Processing</b>             | <b>01</b> |
| Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I / D, Implementation of Sampling Rate Conversion, Multistage Implementation of Sampling Rate Conversion, Sampling Rate Conversion by Arbitrary Factor, Applications of Multi rate Signal Processing, Digital Filter Banks.   |   |           |
| <b>7</b>   | <b>Special Purpose Digital Signal Processor</b> | <b>01</b> |
| Introduction, Computer Architectures for signal processing, General-purpose digital signal processors, Selecting digital signal processors, Implementation of DSP algorithms on general purpose digital signal processors, Special-purpose DSP hardware.   |   |           |
| <b>Books:</b>  |   |           |
| <b>Text:</b>   |   |           |
| <ol style="list-style-type: none"> <li>1. Alan V. Oppenheim and Ronald W. Schaffer, “ Digital Signal Processing”, Pearson, ISBN-10: 0132146355, 13: 978-0132146357</li> <li>2. Emmanuel C. Ifeakor, Barrie W. Jervis, “Digital Signal Processing – A Practical Approach”, 2<sup>nd</sup> Edition, Pearson Education, ISBN 10: 020154413X ISBN 13: 9780201544138</li> </ol>   |   |           |
| <b>References:</b>   |   |           |
| <ol style="list-style-type: none"> <li>1. R. E. Crochiere and L. R. Rabiner, “Multirate Digital Signal Processing”, Pearson, ISBN 0-13-605162-6</li> <li>2. A. Rabiner and Gold, “Theory and Application of Digital Signal Processing”, Prentice Hall, ISBN 10: 0139141014, 13: 9780139141010.</li> <li>3. William D. Stanley, “Digital Signal Processing”, Reston, ; ISBN-10: 083591321X, 13: 978-0835913218</li> <li>4. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing – Principles, Algorithms, and Applications”, 4<sup>th</sup> Edition, Pearson Prentice Hall, ISBN: 9788131710005, 8131710009</li> <li>5. Steven W. Smith., “The Scientist and Engineer’s and Guide”, California Technical Pub, ISBN: 10: 0966017633</li> <li>6. Dale Grover and John R. (Jack) Deller, “Digital Signal Processing and the Microcontroller”, Prentice Hall, ISBN 0-13-754920-2</li> </ol> |   |           |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective I</b><br><b>510105B : Data Mining</b>   |                            |   |
|---|----------------------------|---|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>   | <b>Credit</b><br><b>05</b> | <b>Examination Scheme:</b><br><b>In-Sem : 50 Marks</b><br><b>End-Sem : 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To understand the fundamentals of Data Mining</li> <li>To identify the appropriateness and need of mining the data</li> <li>To learn the preprocessing, mining and post processing of the data</li> <li>To understand various methods, techniques and algorithms in data mining</li> </ul>   |                            |   |
| <b>Course Outcomes:</b><br>On completion of the course the student should be able to- <ul style="list-style-type: none"> <li>Apply basic, intermediate and advanced techniques to mine the data</li> <li>Analyze the output generated by the process of data mining</li> <li>Explore the hidden patterns in the data</li> <li>Optimize the mining process by choosing best data mining technique</li> </ul>   |                            |   |
| <b>Selection of Modules:</b><br>Kindly note that modules 1, 2, 3 are compulsory and select any one module from module number- 4 to 10.  |                            |   |
| <b>Course Contents</b>  |                            |   |
| <b>Module No.</b>   | <b>Module Title</b>        | <b>Credit</b>   |
| <b>1</b>  | <b>Introduction</b>        | <b>01</b>   |
| Data: Data, Information and Knowledge, Attribute Types: Nominal, Binary, Ordinal and Numeric attributes, Discrete versus Continuous Attributes, Introduction to Data Preprocessing, Data Cleaning, Data integration, data reduction, transformation and Data Descriptization.<br>Concept of class: Characterization and Discrimination, basics /Introduction to: Classification and Regression for Predictive Analysis, Mining Frequent Patterns, Associations, and Correlations, Cluster Analysis. |                            |   |
| <b>2</b>  |                            | <b>01</b>   |
| Measuring the Central Tendency: Basics of Mean, Median, and Mode, Measuring the Dispersion of Data, Variance and Standard Deviation. Measuring Data Similarity and Dissimilarity, Data Matrix versus Dissimilarity Matrix, Proximity Measures for Nominal Attributes and Binary Attributes  |                            |   |
| <b>3</b>  |                            | <b>01</b>   |
| Dissimilarity of Numeric Data: Minkowski Distance, Euclidean distance and Manhattan distance, Proximity Measures for Ordinal Attributes, Dissimilarity for Attributes of Mixed Types, Cosine Similarity.  |                            |   |
| <b>Book:</b><br>1. <u>Han, Jiawei Kamber, Micheline Pei and Jian</u> , “Data Mining: Concepts and Techniques”<br>Elsevier Publishers Third Edition/Second Edition, ISBN: 9780123814791, 9780123814807   |                            |   |

|  |                               |           |
|--|-------------------------------|-----------|
| <b>4</b>   | <b>Classification</b>         | <b>02</b> |
| <p>Basic Concepts, General Approach to Classification, Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Visual Mining for Decision Tree Induction, Bayes Classification Methods, Baye's Theorem, Naive Bayesian Classification, Rule-Based Classification, Using IF-THEN Rules for Classification, Rule Extraction from a Decision Tree, Rule Induction Using a Sequential Covering Algorithm, Model Evaluation and Selection: Metrics for Evaluating Classifier Performance, Holdout Method and Random Sub sampling, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost-Benefit and ROC Curves, Techniques to Improve Classification Accuracy: Introducing Ensemble Methods, Bagging, Boosting and Ada Boost, Random Forests, Improving Classification Accuracy of Class-Imbalanced Data.</p> <p>Study of open source/Commercial tool (WEKA/MEKA/Mulan/Panthalo), open source is desirable)</p> <p><b>Book:</b></p> <ol style="list-style-type: none"> <li>1. Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807.</li> </ol>  |                               |           |
| <b>5</b>   | <b>Content Classification</b> | <b>02</b> |
| <p>Bayesian Belief Networks, Concepts and Mechanisms, Training Bayesian Belief Networks, Classification by Back propagation, A Multilayer Feed-Forward Neural Network, Defining a Network Topology, Back propagation, Inside the Black Box: Back propagation and Interpretability, Support Vector Machines: The Case When the Data Are Linearly Separable, The Case When the Data Are Linearly Inseparable, Classification Using Frequent Patterns, Associative Classification, Discriminative Frequent Pattern-Based Classification, Lazy Learners (or Learning from Your Neighbors), k-Nearest-Neighbor Classifiers, Case-Based Reasoning, Other Classification Methods, Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches, Additional Topics Regarding Classification: Multiclass Classification, Semi-Supervised Classification Active Learning, Transfer Learning, Reinforcement learning, Systematic Learning, Holistic learning and multi-perspective learning.</p> <p>Study of open source/Commercial tool (WEKA/MEKA/ Mulan/ Panthalo), open source is desirable)</p> <p><b>Book:</b></p> <ol style="list-style-type: none"> <li>1. Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition/Second Edition, ISBN: 9780123814791, 9780123814807</li> <li>2. Parag Kulkarni, "Reinforcement and Systemic Machine Learning for Decision Making." Wiley-IEEE Press, ISBN: 978-0-470-91999-6.</li> </ol> |                               |           |
| <b>6</b>   | <b>ANN and Data Mining</b>    | <b>02</b> |
| <p>Deep Feed forward Networks: Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms. Convolution Networks: The Convolution Operation, Pooling, Variants of the Basic Convolution Function. Recurrent Neural Networks: Recurrent Neural Networks, Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory and RNNs. Auto-Encoders: Under complete Auto encoders, Regularized Auto encoders, Stochastic Encoders and Decoders, Denoising Auto encoders Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing.</p> <p>Study of open source/Commercial tool (like Tensor Flow Lib., Caffé Lib., Theano.), open source is desirable)</p>  |                               |           |

**References:**

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, ISBN: 9780262337434
2. Online Course: <http://cs224d.stanford.edu/syllabus.html>

|          |   |           |
|----------|---|-----------|
| <b>7</b> | <b>Parallel and Distributed Data Mining</b> | <b>02</b> |
|----------|---|-----------|

Parallel and Distributed Data Mining: Introduction Parallel and Distributed Data Mining, Parallel Design Space: Distributed Memory Machines vs. Shared Memory Systems, Task vs. Data Parallelism, Static vs. Dynamic Load Balancing, Horizontal vs. Vertical Data Layout, Complete vs. Heuristic Candidate Generation.

Algorithms in parallel and distributed data mining: Count Distribution, Data Distribution, Candidate Distribution, Eclat,

Algorithms: Parallel Association Rule Mining: a priori-based Algorithms, Vertical Mining, Pattern-Growth Method,

Parallel Clustering Algorithms: Parallel k-means, Parallel Hierarchical Clustering, Parallel HOP: Clustering Spatial Data, Clustering High-Dimensional Data,

Research Issues and Challenges: High dimensionality, Large size, Data Location, data Types, Data Skew, Dynamic Load Balancing, Incremental Methods, Multi-table Mining, Data Layout, and Indexing Schemes, Parallel DBMS/File systems, Interaction, Pattern Management, and Meta-level Mining.

Distributed Mining Frameworks/Architectures: JAM, PADMA, BODHI, APACHE SPARK.

Introduction to CUDA Parallel programming language: Parallel Programming in CUDA C - CUDA Parallel Programming, Splitting Parallel Blocks, Shared Memory and Synchronization, Constant Memory, Texture Memory, CUDA events, Measuring Performance with Events, Parallel Matrix multiplication, Cuda KNN.

**Books:**

1. Mohammed J. Zaki, Ching-Tien Ho, "Large-Scale Parallel Data Mining", LCNS, Springer Publishers, ISBN: 978-3-540-46502-7
2. Sanguthevar Rajasekaran and John Reif, "Handbook of Parallel Computing Models Algorithms and Applications", CRC Book Press, **ISBN 9781584886235**
3. Liu, Wei-keng Liao, Alok Choudhary, and Jianwei Li, "Parallel Data Mining Algorithms for Association Rules and Clustering"
4. Kimito Funatsu, "New Fundamental Technologies in Data Mining", 978-953-307-547-1
5. Jason Sanders, Edward Kandrot, "CUDA by Example - An Introduction to General-Purpose GPU Programming", ISBN-10: 0-13-138768-5
6. Addison Wesley, Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs by, Elsevier Publishers, ISBN: 978-0201000238

|          |   |           |
|----------|---|-----------|
| <b>8</b> | <b>Spatial and Multimedia Data Mining</b> | <b>02</b> |
|----------|---|-----------|

Data Objects: Generalization of Structured Data, Aggregation and Approximation in Spatial and Multimedia Data Generalization, Generalization of Object Identifiers and Class/Subclass, Hierarchies, Generalization of Class Composition Hierarchies, Construction and Mining of Object Cubes, Generalization-Based Mining of Plan Databases by Divide-and-Conquer.

Spatial Data Mining: Spatial Data Cube Construction and Spatial OLAP, Mining Spatial Association and Co-location Patterns, Spatial Clustering Methods, Spatial Classification and Spatial Trend Analysis, Mining Raster Databases,

Multimedia Data Mining: Similarity Search in Multimedia Data, Multidimensional Analysis of Multimedia Data, Classification and Prediction Analysis of Multimedia Data, Mining Associations in Multimedia Data, Audio and Video Data Mining

|  |   |           |
|--|---|-----------|
| <b>Book:</b>   |   |           |
| 1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques” Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807.  |   |           |
| <b>9</b>   | <b>Data Mining Applications</b>                     | <b>02</b> |
| Mining Complex Data Types, Mining Sequence Data: Time-Series, Symbolic Sequences, and Biological Sequences, Mining Graphs and Networks, Mining Other Kinds of Data, Other Methodologies of Data Mining, Statistical Data Mining, Views on Data Mining Foundations, Visual and Audio Data Mining, Data Mining Applications, Data Mining for Financial Data Analysis, Data Mining for Retail and Telecommunication Industries, Data Mining in Science and Engineering, Data Mining for Intrusion Detection and Prevention, Data Mining and Recommender Systems, Data Mining and Society, Ubiquitous and Invisible Data Mining, Privacy, Security, and Social Impacts of Data Mining, Data Mining Trends.   |   |           |
| <b>Book:</b>   |   |           |
| 1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and techniques” Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807.  |   |           |
| <b>10</b>  | <b>Pattern Discovery and Social Networks Mining</b> | <b>02</b> |
| <p><b>Graph Mining: Methods for Mining Frequent Subgraphs:</b> A priori-based Approach, Pattern-Growth Approach, Mining Variant and Constrained Substructure Patterns: Mining Closed Frequent Substructures Extension of Pattern-Growth Approach: Mining, Alternative Substructure Patterns, Constraint-Based Mining of Substructure Patterns, Mining Approximate Frequent Substructures, Mining Coherent Substructures Mining Dense Substructures, Applications: Graph Indexing with Discriminative Frequent Substructures Substructure Similarity Search in Graph Databases Classification and Cluster Analysis Using Graph Patterns</p> <p><b>Social Network Analysis:</b> Introduction Social Network, Characteristics of Social Networks, Link Mining: Tasks and Challenges, Mining on Social Networks: Link Prediction, Mining Customer Networks for Viral Marketing, Mining Newsgroups Using Networks, Community Mining from Multi relational Networks Multi relational Data Mining: Introduction Multi relational Data Mining ILP Approach to Multi relational Classification Tuple ID Propagation, Multi relational Classification Using Tuple ID Propagation Multi relational Clustering with User Guidance.</p> |   |           |
| <b>Books:</b>  |   |           |
| 1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques”, Elsevier Publishers Second Edition, ISBN: 9780123814791, 9780123814807.   |   |           |
| 2. Matthew A. Russell, "Mining the Social Web,;Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition  |   |           |
| 3. Maksim Tsvetovat,Alexander Kouznetsov, "Social Network Analysis for Startups:Finding connections on the social web", Shroff Publishers , ISBN: 10: 1449306462   |   |           |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective I</b><br><b>510105C : Network Design and Analysis</b>   |   |   |
|---|---|---|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>   | <b>Credit</b><br><b>05</b>                    | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem: 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To develop a comprehensive understanding of computer Networks</li> <li>To study design issues in networks.</li> <li>To learn estimation of network requirements.</li> <li>To learn Enterprise network design.</li> <li>To understand various issues hindering the performance of the network.</li> </ul>  |   |   |
| <b>Course Outcomes:</b> After completion of the course, students should be able to <ul style="list-style-type: none"> <li>Apply the knowledge to design computer networks</li> <li>Analyze the performance of networks based on chosen metrics</li> <li>Design routing schemes for optimized routing</li> <li>Choose appropriate and advanced techniques to build the computer network</li> </ul>   |   |   |
| <b>Selection of Modules:</b> All modules 1 to 5 are compulsory.   |   |   |
| <b>Course Contents</b>  |   |   |
| <b>1</b>  | <b>Introduction</b>                           | <b>01</b>   |
| Overview of network analysis and design process, Network design issues, requirement analysis (user, application, device, network) concepts, Routing and forwarding, resource allocation, general principles of network design, network characteristics, performance metric in networks  |   |   |
| <b>2</b>  | <b>Physical and Logical network design</b>    | <b>01</b>   |
| Topologies, Physical addressing, switching, IP packet format, IP routing method, routing using masks, fragmentation of IP packet, IPv6, advanced features of IP routers: filtering, IP QoS, NAT, routers  |   |   |
| <b>3</b>  | <b>Queuing Theory</b>                         | <b>01</b>   |
| Delay Models in Data Networks, Queuing Models- Little's Theorem, Application of Little's Theorem, Queuing Systems: M/M/1, M/M/2, M/M/m, M/M/ $\infty$ , M/M/m/m, M/M/m/q, M/M/1/N, D/D/1, M/G/1 System, M/G/1 Queues with Vacations, Priority Queuing.  |   |   |
| <b>4</b>  | <b>Modelling N/W as Graph</b>                 | <b>01</b>   |
| Graph terminology, representation of networks, fundamental graph algorithms, shortest path, link prediction algorithms-Dijkstra's, Bellman's, Floyd's, Incremental shortest path algorithm.   |   |   |
| <b>5</b>  | <b>Methods of Ensuring Quality of Service</b> | <b>01</b>   |
| Methods of ensuring quality of service – introduction, applications and QoS, QoS mechanisms, Queue management algorithms, feedback, resource reservation, traffic engineering, IP QoS Next generation networks, cyber physical systems, smart mobiles, cards and device networks, smart devices and services, network testing, testing tool – wireshark   |   |   |
| <b>Books:</b> <ol style="list-style-type: none"> <li>1. Aaron Kershenbaum, "Telecommunications Network Design Algorithm", McGraw Hill education (India), Edition 2014, ISBN-10: 0070342288</li> <li>2. James McCabe, "N/W analysis, Architecture and Design", Elsevier, 978-0-12-370480-1</li> <li>3. Pablo Pavon Marino, "Optimization of Computer Networks : Modeling and algorithms – A hands on approach", Wiley Publication, ISBN: 9781119013358</li> <li>4. Olifer, Victor Olifer, "Computer Networks, Principles, Technologies and Protocols for network design", Wiley India, ISBN: 13: 9788126509171.</li> </ol> |   |   |



| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective I</b><br><b>510105 D : Data Algorithms</b>   |                                    |  |
|--|------------------------------------|--|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>  | <b>Credit</b><br><b>05</b>         | <b>Examination Scheme:</b><br><b>Internal Assessment : 50 Marks</b><br><b>End- Sem: 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To study concepts of sorting and searching for voluminous data</li> <li>To learn functionalities of advanced network algorithms</li> <li>To understand the means for data and market prediction</li> <li>To study various performance parameters for algorithmic</li> </ul>                      |                                    |  |
| <b>Course Outcomes:</b><br>After completion of the course, students should be able to- <ul style="list-style-type: none"> <li>Apply the concept of advanced algorithms for searching, sorting and network algorithms</li> <li>Estimate the complexity of various algorithms and Measure the Choose appropriate algorithm to solve data centric problems</li> </ul> |                                    |  |
| <b>Selection of Modules:</b> Modules 1 to 4 are compulsory and select any one from modules 5 and 6.  |                                    |  |
| <b>Course Contents</b>   |                                    |  |
| <b>Module No</b>   | <b>Module Title</b>                | <b>Credit</b>  |
| <b>1</b>   | <b>Secondary Sorting Algorithm</b> | <b>01</b>  |
| Secondary Sort: Introduction, Solutions to the Secondary Sort Problem, Map Reduce Solution to Secondary Sort, Spark Solution to Secondary Sort, Secondary Sorting Technique, Complete Example of Secondary Sorting, Top N, Formalized Map Reduce Implementation: Unique Keys & Non unique Keys, Spark Implementation: Unique Keys, Non unique Keys.                |                                    |  |
| <b>2</b>   | <b>Left Outer Join Algorithms</b>  | <b>01</b>  |
| Left Outer Join: Implementation of Left Outer Join in Map Reduce with Example, Spark Implementation of Left Outer Join().  |                                    |  |
| <b>3</b>   | <b>Order Inversion</b>             | <b>01</b>  |
| Order Inversion : Example of the Order Inversion Pattern, Map Reduce Implementation of the Order Inversion Pattern, Formal Definition of Moving Average.   |                                    |  |
| <b>4</b>   | <b>Market Basket Analysis</b>      | <b>01</b>  |
| Market Basket Analysis : MBA Goals, Application Areas for MBA, Market Basket Analysis Using MapReduce, Spark Solution, POJO Common Friends Solution.   |                                    |  |
| <b>5</b>   | <b>Scatter Search Algorithms</b>   | <b>01</b>  |
| Introduction of SS algorithms, working principle of SS algorithms / scatter search methodology and basic scatter search design and advance designs, SS Algorithm, Diversification Method, Reference set update method, Improvement Methods, Subset Generation, training method.  |                                    |  |
| <b>6</b>   | <b>Network Algorithms</b>          | <b>01</b>  |
| Bellman's equation and acyclic networks, The Network Simplex Algorithm - The minimum cost flow problem, Tree solutions, Constructing an admissible tree structure.   |                                    |  |
| <b>Books :</b>   |                                    |  |
| <ol style="list-style-type: none"> <li>1. Mahmoud Parsian, "Data Algorithms", O'Reilly, ISBN: 10 1491906189</li> <li>2. Manuel Laguna, Rafael Martí, "Metaheuristic Procedures for Training Neural Networks" Springer (2006) ISBN - 978-0-387-33415-8</li> <li>3. Dieter Jungnickel, "Graphs, Networks and Algorithms", Springer, 978-3-540-72779-8</li> </ol>     |                                    |  |



| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510206 : Laboratory Proficiency I</b>  |                            |  |
|---|----------------------------|--|
| <b>Teaching Scheme:</b><br><b>Practical: 08 Hours/Week</b>  | <b>Credit</b><br><b>04</b> | <b>Examination Scheme:</b><br><b>Presentation: 50 Marks</b><br><b>TW: 50 Marks</b> |
| <p>Laboratory Proficiency I (LP I) is companion course of theory courses (core and elective) in Semester I. It is recommended that set of assignments or at least one mini-project/study project per course is to be completed. Set of problem statements are suggested. Course/ Laboratory instructor may frame suitable problem statements. Student has to submit a report/Journal consisting of appropriate documents - prologue, Certificate, table of contents, and other suitable write up like (Introduction, motivation, aim and objectives, outcomes, brief theory, requirements analysis, design aspects, algorithms, mathematical model, complexity analysis, results, analysis and conclusions). Softcopy of report /journal and code is to be maintained by department/ institute in digital repository.</p> <p><b>Suitable platform/framework/language is to be used for completing mini-project/assignments.</b></p> <p><b>Guidelines for Term Work Assessment</b></p> <p>Continuous assessment of laboratory work is done based on performance of student. Each assignment/ mini project assessment is to be done based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as mini project assessment include- timely completion, performance, innovation, efficient codes, usability, documentation and adhering to SDLC comprehensively.</p> <p><b>Guidelines for Examination</b></p> <p>It is recommended that examination should be conducted as presentation by student based on one of the mini projects completed and the content understanding of laboratory work.</p> |                            |  |
| <b>Suggested List of Laboratory Assignments</b>   |                            |  |
| <b>A. Research Methodology</b>  |                            |  |
| <ol style="list-style-type: none"> <li>1. Use an academic web search to locate a journal paper which describes a design outcome in your field of interest (i.e. your engineering discipline). You must enter several keywords which relate to your topic. Read the paper and, using your own words, demonstrate your understanding of the paper by: <ul style="list-style-type: none"> <li>▪ Brief Contribution</li> <li>▪ Performance metric, data set, comparative analysis and outcomes</li> <li>▪ Writing out the major conclusions of the paper;</li> <li>▪ Outlining the verification method(s) used to support these conclusions</li> <li>▪ Describing the author's reflective comments on the quality of the design (positive and negative).</li> <li>▪ The positive and negative environmental impacts;</li> </ul> <p>After reading a published research paper, write down the research question you think the author have addressed in undertaking this research. Do you think the paper adequately supports the conclusions reached in addressing the question?</p> </li> </ol>  |                            |  |

|    |   |
|----|---|
| 2. | <p>Consider a journal article in your discipline that was published approximately five years ago. Note the keywords and type them into one of the web-based academic search engines (e.g. googlescholar.com). Does the original article appear in the search results? How many citations does this article have? Have the same authors published further work in this field?</p> <p>Compare the citations of this paper with those from the most highly cited paper in the search results? How many citations does this highly cited article have? If this paper was published before your original article, is it cited in your article? Do you think this high-cited paper should have been listed as a reference in your original article? Give reasons for your decision.</p> <p>Read a journal paper from your discipline. Following the format of patents, write out one or more important outcomes from the paper in terms of one or more Patent Claims 1, 2....</p> <p>.These claims must not only be new, they must be not-obvious from previous work</p>  |
| 3. | <p>a) Literature Review Quality: Using a Journal paper selected in your engineering discipline of interest, write a 400 word evaluation of the quality of Literature Review. In particular, review the quality and relevance of cited papers, the comments made on those papers contribution to the general field, and any omission of papers which are of major importance in the field.</p> <p>b) Develop a new research proposal from a published paper: From selected published Journal paper, read the paper. In particular read the discussion and conclusion section and find Suggestions for further work. Apply one of the question words(How?, Why?, What?, When?) and write one or more research questions arising from this paper. This can be used as guide to help you to develop your own research project proposal</p>  |
| 4. | <p>a) Download a set of weather data from the Internet covering the temperature and atmospheric pressure over a four day period. Present the data using 2D and 3D plots, and so deduce if the weather conditions are trending either higher or lower over this four day period. (Possible web sites include <a href="http://www.bom.gov.au/climate/data/">http://www.bom.gov.au/climate/data/</a> and <a href="http://www.silkeborg-vejret.dk/english/regn.php">http://www.silkeborg-vejret.dk/english/regn.php</a>).</p> <p>b) Numerical modeling: Find a paper in which nunicricil modeling has been used to verify the experimental results. Comment on the differences between the experimental and modeling results. Have the authors commented on the accuracy of the experimental and modeling procedures? What suggestions do you have to improve the quality of the modeling reported in the paper?</p> <p>c) Statistical review: In your engineering discipline review a published paper which includes a statistical analysis. Write a brief report on the statistical methods used. Can you suggest an improved statistical analysis? Suggest some additional parameters that might have been measured during the data acquisition stage and so explain how you would analyze the total data set to deduce the influence (and statistical significance) of these additional measurements.</p> |

| <b>B. Bio-Inspired Algorithms</b>                    |   |
|--|---|
| <b>1. Ant Colony Algorithm:</b>                      | The Traveling Salesman Problem is a problem of a salesman who, starting from his hometown, wants to find the shortest tour that takes him through a given set of customer cities and then back home, visiting each customer city exactly once." Each city is accessible from all other cities.. Use ant colony algorithm for generating good solutions to both symmetric and asymmetric instances of the Traveling Salesman Problem. Use appropriate representation for graph and an appropriate heuristic that defines the distance between any two nodes of the graph. Use parallel approach to optimize solution |
| <b>2.</b>  | Job Scheduling using PSO, Optimization techniques for N-Queen's problem, Management and allocation of resources in a safety division of any pharmaceutical company, To automate the strategic planning process in an industry., Optimize Staff allocation problem in an organization, Railway Transportation/ Air Transportation : A case study of Transportation problem, Time table generation.   |
| <b>C. Software Development &amp; Version Control</b> |   |
| <b>1.</b>  | Study of any open source system/application software like Version Control in Linux Kernel   |
| <b>D. Embedded and Real Time Operating Systems</b>   |   |
| <b>1.</b>  | Simulation/ Design, planning and modeling of a Real-Time / Embedded System for- (any one) <ul style="list-style-type: none"> <li>• Alarm system for elderly people (Fall detection, Heart attack)</li> <li>• Medication machine for patients in ICU</li> <li>• Smart traffic control</li> <li>• Autonomous car</li> <li>• Smart home ( sound system, temperature, light)</li> <li>• Control of an autonomous quadrocopter (e.g. for surveillance tasks)</li> <li>• Control of a rail station</li> <li>• Video conference system</li> <li>• Washing machine</li> </ul>   |
| <b>E. Elective I</b>                                 |   |
|  | Course instructor is authorized to frame suitable problem statement for Assignments/ mini project   |

# Semester II

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510108 : Operations Research</b>   |  |   |
|---|--|---|
| <b>Teaching Scheme:</b><br><b>TH: 04 Hours/Week</b>   | <b>Credit</b><br><b>04</b>                               | <b>Examination Scheme:</b><br><b>In-Sem : 50 Marks</b><br><b>End-Sem : 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To introduce students to use quantitative methods and techniques for effective analysis of decisions making</li> <li>To understand the model formulation and applications that is used in solving business decision problems.</li> <li>To introduce students to optimization approaches and fundamental solution.</li> <li>To learn a variety of ways in which deterministic and stochastic models in Operations Research can be used</li> </ul> |  |   |
| <b>Course Outcomes:</b><br>After completion of the course, students should be able to- <ul style="list-style-type: none"> <li>Identify the characteristics of different types of decision-making environments</li> <li>Use appropriate decision making approaches and tools</li> <li>Build various dynamic and adaptive models</li> <li>Develop critical thinking and objective analysis of decision problems</li> <li>Apply the OR techniques for efficacy</li> </ul>  |  |   |
| <b>Course Contents</b>  |  |   |
| <b>Unit I</b>   | <b>Linear Programming</b>                                | <b>08 Hours</b>   |
| Introduction, Modeling with Linear 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.  |  |   |
| <b>Unit II</b>  | <b>Duality in Linear Programming</b>                     | <b>08 Hours</b>   |
| 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.   |  |   |
| <b>Unit III</b>   | <b>The Transportation Problem and Assignment Problem</b> | <b>08 Hours</b>   |
| 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.  |  |   |
| <b>Unit IV</b>  | <b>Game Theory and Dynamic Programming</b>               | <b>08 Hours</b>   |
| Introduction, 2 person zero sum games, Maximin - Minimax 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 – B&B 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 & 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.   |  |          |
| <b>Books:</b>   |  |          |
| <b>Text:</b>  |  |          |
| <ol style="list-style-type: none"> <li>1. Hamdy A. Taha "Operations Research" Pearson Education, 8<sup>th</sup> Edition, ISBN: 978-81-317-1104-0</li> <li>2. Gillett, "Introduction to Operation Research", TMH, ISBN: 0070232458</li> </ol>  |  |          |
| <b>References:</b>  |  |          |
| <ol style="list-style-type: none"> <li>1. S.D. Sharma, , Kedarnath, Ramnath &amp; Co., "Operations Research" Meerut,2009, ISBN: 978-81-224-2288-7</li> <li>2. Hrvey M. Wagner, Principles of Operations Research, Second Edition, Prentice Hall of India Ltd., 1980, ISBN: 10: 0137095767 ,13: 9780137095766 ..</li> <li>3. V.K. Kapoor, Operations Research, S. Chand Publishers, New Delhi, 2004, ISBN: 9788180548543, 8180548546 .</li> <li>4. R. Paneer Selvam, Operations Research, Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008, ISBN: 10: 8120329287, : 9788120329287.</li> </ol> |  |          |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510109 : System Simulation and Modeling</b>  |                                       |  |
|---|---------------------------------------|--|
| <b>Teaching Scheme:</b><br><b>TH: 5 Hours/Week</b>  | <b>Credit</b><br><b>05</b>            | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem : 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To learn the concepts of Systems behavior</li> <li>To understand various Modeling schemes</li> <li>To acquaint with the theory of simulation</li> <li>To learn applications to simulate the systems</li> </ul>   |                                       |  |
| <b>Course Outcomes:</b><br>After completion of the course, students should be able to- <ul style="list-style-type: none"> <li>To apply modeling to understand system behavior</li> <li>To design the simulation scheme for particular system</li> <li>To analyze the modeled and simulated systems</li> <li>To compare the results of simulations confined to real world application</li> </ul>   |                                       |  |
| <b>Course Contents</b>  |                                       |  |
| <b>Unit I</b>   | <b>Introduction</b>                   | <b>08 Hours</b>  |
| The Nature of Systems, Event-Driven Model, Characterizing Systems, Simulation Diagrams, The Systems Approach. <b>Dynamical Systems:</b> Initial-Value Problems, Higher-Order Systems, Autonomous Dynamic Systems, Multiple-Time-Based Systems, Handling Empirical Data.   |                                       |  |
| <b>Unit II</b>  | <b>Stochastic Data Representation</b> | <b>08 Hours</b>  |
| Uniformly Distributed Random Numbers, Statistical Properties of U [0,1] Generators, Generation of Non-Uniform Random Variates, Generation of Arbitrary Random Variates, Random Processes, Characterizing Random Processes, Generating Random Processes, Random Walks, White Noise. <b>Stochastic Data Representation:</b> Random Process Models, Moving-Average (MA) processes, Autoregressive (AR) processes, Big-Z notation, Autoregressive Moving-Average (ARMA) models, additive noise. |                                       |  |
| <b>Unit III</b>   | <b>Sampled Systems</b>                | <b>08 Hours</b>  |
| Sampled Systems, Spatial Systems, Finite-Difference Formulae, Partial Differential Equations, Finite Differences for Partial Derivatives, Constraint Propagation. <b>Exogenous Signals and Events:</b> Disturbance Signals, State Machines, Petri Nets, Analysis of Petri Nets, System Encapsulation.   |                                       |  |
| <b>Unit IV</b>  | <b>Stochastic Data Representation</b> | <b>08 Hours</b>  |
| Modeling Input Signals, Nomenclature, Discrete Delays, Distributed Delays, System Integration, Linear Systems, Motion Control Models, Numerical Experimentation. <b>Event-Driven Models:</b> Simulation Diagrams, Queuing Theory, M/M/1 Queues, Simulating Queuing Systems, Finite-Capacity Queues, Multiple Servers, M/M/c Queues.   |                                       |  |



|   |   |                 |
|---|---|-----------------|
| <b>Unit V</b>   | <b>Behavior of a Stochastic Process</b>   | <b>08 Hours</b> |
| Transient and Steady-State Behavior of a Stochastic Process, Types of Simulations with Regard to Output Analysis, Statistical Analysis for Terminating Simulations, Statistical Analysis for Steady-State Parameters, Statistical Analysis for Steady-State Cycle Parameters, Multiple Measures of Performance, Time Plots of Important Variables |   |                 |
| <b>Unit VI</b>  | <b>Simulation of Manufacturing System</b> | <b>08 Hours</b> |
| Simulation of Manufacturing System: Introduction, Objectives of Simulation in Manufacturing, Simulation Software for Manufacturing, Modeling System Randomness with extended example, A simulation case study of a Metal-Parts Manufacturing Facility.  |   |                 |
| <b>Books</b>  |   |                 |
| <b>Text:</b>  |   |                 |
| <ol style="list-style-type: none"> <li>1. Frank L. Severance, "System Modeling and Simulation a Introduction", Severance, John Wiley &amp; Sons Ltd, ISBN 9812-53-175-0.</li> <li>2. Averill M Law, "Simulation Modeling and Analysis", McGraw Hill Education, ISBN-13: 978-0-07- 066733-4.</li> </ol>  |   |                 |
| <b>Reference:</b>   |   |                 |
| <ol style="list-style-type: none"> <li>1. Daniele Gianni, Andrea D'Ambrogio, and Andreas Tolk (editors), Modeling and Simulation-Based Systems Engineering Handbook, CRC Press, 2014, ISBN:9781138748941</li> <li>2. Gould, H. and Tobochnik, J., Computer Simulation Methods part I and II (Addison Wesley, 1987)</li> </ol>                     |   |                 |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510110 : Machine Learning</b>  |   |  |
|---|---|--|
| <b>Teaching Scheme:</b><br><b>TH: 04 Hours/Week</b>   | <b>Credit</b><br><b>04</b>                  | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem : 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To understand Human learning aspects</li> <li>To learn the primitives in learning process by computer</li> <li>To Understand nature of problems solved with Machine Learning</li> <li>To acquaint with the basic concepts and techniques of Machine Learning.</li> <li>To learn the means for categorization of the information</li> </ul>  |   |  |
| <b>Course Outcomes :</b><br>After completion of the course, students should be able to- <ul style="list-style-type: none"> <li>Acquire fundamental knowledge of learning theory</li> <li>Design and evaluate various machine learning algorithms</li> <li>Use machine learning methods for multivariate data analysis in various scientific fields</li> <li>Choose and apply appropriate Machine Learning Techniques for analysis, forecasting, categorization and clustering of the data</li> </ul>  |   |  |
| <b>Course Contents</b>  |   |  |
| <b>Unit I</b>   | <b>Machine Learning Concepts</b>            | <b>09 Hours</b>  |
| Introduction to Machine Learning, Machine Learning applications, Types of learning: Supervised, Unsupervised and semi-supervised, reinforcement learning techniques, Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models, Predictive and descriptive learning, Classification concepts, Binary and multi-class classification  |   |  |
| <b>Unit II</b>  | <b>Learning Theory</b>                      | <b>09 Hours</b>  |
| Features: Feature Extraction, Feature Construction and Transformation, Feature Selection, Dimensionality Reduction: Subset selection, the Curse of dimensionality, Principle Components analysis, Independent Component analysis, Factor analysis, Multidimensional scaling, Linear discriminant analysis, Bias/Variance tradeoff, Union and chernoff/Hoeffding bounds, VC dimension, Probably Approximately Correct (PAC) learning, Concept learning, the hypothesis space, Least general generalization, Internal disjunction, Paths through the hypothesis space, model Evaluation and selection |   |  |
| <b>Unit III</b>   | <b>Geometric Models</b>                     | <b>09 Hours</b>  |
| Regression, Logistic regression , Assessing performance of regression - Error measures, Overfitting, Least square method, Multivariate Linear regression, Regression for Classification, Perceptron, Multi-layer perceptron, Simple neural network, Kernel based methods, Support vector machines(SVM), Soft margin SVM, Support Vector Machines as a linear and non-linear classifier, Limitations of SVM, Concept of Relevance Vector, K-nearest neighbor algorithm   |   |  |
| <b>Unit IV</b>  | <b>Logical, Grouping And Grading Models</b> | <b>09 Hours</b>  |

Decision Tree Representation, Alternative measures for selecting attributes, Decision tree algorithm: ID3, Minimum Description length decision trees, Ranking and probability estimation trees, Regression trees, Clustering trees, Rule learning for subgroup discovery, Association rule mining, Distance based clustering- K-means algorithm, Choosing number of clusters, Clustering around medoids – silhouettes, Hierarchical clustering, Ensemble methods: Bagging and Boosting

|               |                             |                 |
|---------------|-----------------------------|-----------------|
| <b>Unit V</b> | <b>Probabilistic Models</b> | <b>09 Hours</b> |
|---------------|-----------------------------|-----------------|

Uncertainty, Normal distribution and its geometric interpretations, Baye's theorem, Naïve Bayes Classifier, Bayesian network, Discriminative learning with maximum likelihood, Probabilistic models with hidden variables, Hidden Markov model, Expectation Maximization methods, Gaussian Mixtures and compression based models

|                |   |                 |
|----------------|---|-----------------|
| <b>Unit VI</b> | <b>Case Studies on Advanced Machine Learning Techniques</b> | <b>09 Hours</b> |
|----------------|---|-----------------|

Profiling the online storefronts of counterfeit merchandise, Detecting malicious websites in adversarial classification, Credit card fraud detection, Topic models of the underground Internet economy, Learning to rate vulnerabilities and predict exploits.

#### **Books:**

##### **Text:**

1. Peter Flach, Machine Learning: The Art and Science of Algorithms that make sense of data, Cambridge University Press, 1<sup>st</sup> Edition, 2012, ISBN No.: 978-1-316-50611-0
2. Ethem Alpaydin, Introduction to Machine Learning, PHI, 2<sup>nd</sup> edition, 2013, 978-0-262-01243-0
3. Kevin Murphy, Machine Learning: a Probabilistic Approach, MIT Press, 1<sup>st</sup> Edition, 2012, ISBN No.: 978-0262-30616-4

##### **Reference:**

1. C.M. Bishop, Pattern Recognition and Machine learning, Springer, 1<sup>st</sup> Edition, 2013, ISBN No.: 978-81-322-0906-5
2. Hastie, Tibshirani, Friedman, Introduction to statistical machine learning with applications in R, Springer, 2<sup>nd</sup> Edition, 2013, ISBN No.: 978-1-4614-7138-7
3. Tom Mitchell, Machine Learning, McGraw Hill, 1997, 0-07-042807-7
4. Parag Kulkarni, Reinforcement and Systemic Machine learning for Decision Making, Wiley-IEEE Press, 2012, 978-0-470-91999-6
5. M. F. Der, L. K. Saul, S. Savage, and G. M. Voelker (2014). Knock it off: profiling the online storefronts of counterfeit merchandise. In Proceedings of the Twentieth ACM Conference on Knowledge Discovery and Data Mining (KDD-14), pages 1759-1768. New York, NY.
6. J. T. Ma, L. K. Saul, S. Savage, and G. M. Voelker (2011). Learning to detect malicious URLs. ACM Transactions on Intelligent Systems and Technology 2(3), pages 30:1-24.
7. D.-K. Kim, G. M. Voelker, and L. K. Saul (2013). A variational approximation for topic modeling of hierarchical corpora. To appear in Proceedings of the 30th International Conference on Machine Learning (ICML-13). Atlanta, GA.
8. M. Bozorgi, L. K. Saul, S. Savage, and G. M. Voelker (2010). Beyond heuristics: learning to classify vulnerabilities and predict exploits. In Proceedings of the Sixteenth ACM Conference on Knowledge Discovery and Data Mining (KDD-10), pages 105-113. Washington, DC

**Savitribai Phule Pune University**  
**Master of Computer Engineering (2017 Course)**  
**Elective II**  
**510111A : Image Processing**

|   |                            |  |
|---|----------------------------|--|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b> | <b>Credit</b><br><b>05</b> | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem : 50 Marks</b> |
|---|----------------------------|--|

**Course Objectives :**

- To study image processing concepts
- To study mathematics and algorithms for image processing
- To study various methods of image processing in spatial and frequency domain
- To understand various image processing applications

**Course Outcomes :**

After completion of the course, students should be able to-

- Apply relevant mathematics required for image processing
- Perform and analyze various image processing methods using appropriate tools
- Use various image processing methods in spatial and frequency domain
- Explore current trends and future scope in image processing applications

**Selection of Modules:**

Kindly note that modules 1, 2 are compulsory and select any three (03) modules from remaining modules 3 to 11.

**Course Contents**

| <b>Module No.</b>   | <b>Module Title</b>                  | <b>Credit</b> |
|---|--------------------------------------|---------------|
| <b>1</b>  | <b>Image Processing Fundamentals</b> | <b>01</b>     |
| Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and Quantization, Image types, Image file formats, Human visual system, Elements of an image processing system, Fundamental steps in image processing, Component labeling algorithm, Morphological image processing   |                                      |               |
| <b>2</b>  | <b>Image Processing Fundamentals</b> | <b>01</b>     |
| <b>Image Enhancement by Spatial domain image enhancement:</b> Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian <b>Image Enhancement by Frequency domain Image enhancement :</b> Low pass filtering in frequency domain (Ideal, Butterworth, Gaussian), High pass filter in frequency domain (ideal, Butterworth, Gaussian).<br><b>Case Study: Open Source image processing software:</b> Octave, OpenCV, Scilab |                                      |               |
| <b>3</b>  | <b>Image segmentation</b>            | <b>01</b>     |
| Classification of image segmentation techniques, thresholding based image segmentation, edge based segmentation, edge detection, edge linking, Hough transform, watershed transform, clustering techniques, region approach   |                                      |               |
| <b>4</b>  | <b>Image restoration</b>             | <b>01</b>     |
| Image degradation, Image restoration model, linear and non-linear image restoration, image denoising  |                                      |               |
| <b>5</b>  | <b>Multi resolution analysis</b>     | <b>01</b>     |
| Image Pyramids, Multi resolution expansion, Fast Wavelet Transforms, Lifting scheme   |                                      |               |
| <b>6</b>  | <b>Feature extraction</b>            | <b>01</b>     |

|   |                                       |           |
|---|---------------------------------------|-----------|
| Shape Descriptors- Classification of shape descriptor techniques, contour based ( Boundary following , chain code, signature, Polygon approximation), region based- (Euler number, shape matrix, statistical moments), feature extraction in transform domain(Fourier descriptor)<br>Relational descriptor, Use of Principal components for description   |                                       |           |
| <b>7</b>  | <b>Image Compression</b>              | <b>01</b> |
| Need and classification of image compression techniques, run-length coding, Shannon Fano coding, Huffman coding, Scalar and vector quantization, Compression Standards-JPEG/MPEG, Video compression   |                                       |           |
| <b>8</b>  | <b>Steganography and Watermarking</b> | <b>01</b> |
| Information hiding, Steganography: introduction, properties, models, stegnoanalysis, Watermarking : introduction, properties, models, security, content authentication  |                                       |           |
| <b>9</b>  | <b>Satellite Image Processing</b>     | <b>01</b> |
| Concepts and Foundations of Remote Sensing, GPS, GIS, Elements of Photographic Systems, Basic Principles of Photogrammetry, Multispectral, Thermal, and Hyper spectral Sensing, Earth Resource Satellites Operating in the Optical Spectrum   |                                       |           |
| <b>10</b>   | <b>Medical Image Processing</b>       | <b>01</b> |
| Introduction, Medical Image Enhancement, Segmentation, Medical Image Analysis (Images of Brain MRI or Cardiac MRI or Breast Cancer Risk) Validation of registration accuracy  |                                       |           |
| <b>11</b>   | <b>Object Recognition</b>             | <b>01</b> |
| Introduction, Computer Vision, Tensor Methods in Computer Vision, Classifications Methods and Algorithm, Object Detection and Tracking, Object Recognition  |                                       |           |
| <b>Books :</b>  |                                       |           |
| <b>Text:</b>  |                                       |           |
| <ol style="list-style-type: none"> <li>1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image processing", Pearson Education , Fourth Impression, 2008, ISBN: 978-81-7758-898-9.</li> <li>2. A. K. Jain, "Fundamentals of Digital Image Processing", PHI, ISBN-978-81- 203-0929-6.</li> <li>3. S. Annadurai, R. Shanmugalakshmi, "Fundamentals of Digital Image Processing", Pearson Education, First Edition, 2007, ISBN-8177584790.</li> <li>4. Boguslaw Cyganek, "Object Detection and Recognition in Digital Images: Theory and Practice", Wiley, First Edition, 2013, ISBN: 978-0-470-97637-1.</li> <li>5. Ingemar Cox, Matthew Miller, Jeffrey Bloom, Jessica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", <a href="#">Morgan Kaufmann</a> (MK), ISBN : 978-0-12-372585-1.</li> <li>6. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman," Remote Sensing and Image Interpretation", Wiley, Seventh Edition, 2015, ISBN: 978-1-118-91947-7</li> </ol> |                                       |           |
| <b>Reference:</b>   |                                       |           |
| <ol style="list-style-type: none"> <li>1. Isaac Bankman, "Handbook of Medical Imaging", Academic Press, Second Edition, 2008, ISBN: 9780080559148.</li> <li>2. Jayaraman, Esakkirajan,Veerakumar," Digital image processing", Mc Graw Hill, Second reprint- 2010, ISBN(13): 978-0-07-01447-8, ISBN(10):0-07-014479-6</li> <li>3. NPTEL Video Lecturers: Title: Digital Image Processing, Prof. P. K. Biswas, IIT Khargapur, A joint venture by IISc and IITs, funded by MHRD, Govt of India, url: <a href="http://nptel.ac.in/courses/117105079">http://nptel.ac.in/courses/117105079</a></li> </ol>  |                                       |           |

**Savitribai Phule Pune University**  
**Master of Computer Engineering (2017 Course)**  
**Elective II**  
**510111B : Web Mining**

**Teaching Scheme:**  
**TH: 05 Hours/Week**

**Credit**  
**05**

**Examination Scheme:**  
**In- Sem: 50 Marks**  
**End- Sem : 50 Marks**

**Course Objectives:**

- To study concepts of Web Information Retrieval;
- To understand concepts of Social Network Analysis;
- To know various applications of Web Mining;

**Course Outcomes:**

After completion of the course, students should be able to-

- Transform Web Information into analytical form;
- Use various means to analyze and synthesize Social Networking information
- Use appropriate tools used in analyzing the web information

**Selection of Modules:**

Kindly note that modules 1, 2 are compulsory and select any three (03) modules from modules 3 to 6.

**Course Contents**

| <b>Module No.</b>   | <b>Module Title</b>   | <b>Credit</b> |
|---|---|---------------|
| <b>1</b>  | <b>Information Retrieval and Social Network Analysis</b>      | <b>01</b>     |
| Basic Concepts of Information Retrieval Information Retrieval Models, Relevance Feedback, Evaluation Measures, Text and Web Page Pre-Processing, Inverted Index and Its Compression, Latent Semantic Indexing, Web Search, Meta-Search: Combining Multiple Rankings, Web Spamming.  |   |               |
| <b>2</b>  | <b>Social Network Analysis</b>                                | <b>01</b>     |
| Social Network Analysis, Co-Citation and Bibliographic, Page Rank, HITS, Community Discovery. Web Crawling: A Basic Crawler Algorithm, Implementation Issues, Universal Crawlers, Topical Crawlers, Evaluation, Crawler Ethics and Conflicts.   |   |               |
| <b>3</b>  | <b>Structured Data Extraction and Information Integration</b> | <b>01</b>     |
| Wrapper Generation, Preliminaries, Wrapper Induction, Instance-Based Wrapper Learning, Automatic Wrapper Generation: Problems, String Matching and Tree Matching, Multiple Alignment, Building DOM Trees, Extraction Based on a Single List Page: Flat Data Records, Extraction Based on a Single List Page: Nested Data Records, Extraction Based on Multiple Pages. |   |               |
| <b>4</b>  | <b>Schema Matching</b>  | <b>01</b>     |
| Introduction to Schema Matching, Pre-Processing for Schema Matching, Schema-Level Matching, Domain and Instance-Level Matching, Combining Similarities, 1:m Match, Integration of Web Query Interfaces, Constructing a Unified Global Query Interface.  |   |               |
| <b>5</b>  | <b>Mining and Sentiment Analysis</b>                          | <b>01</b>     |

The Problem of Opinion Mining, Document Sentiment Classification, Sentence Subjectivity and Sentiment Classification, Opinion Lexicon Expansion, Aspect-Based Opinion Mining, Mining Comparative Opinions, Opinion Search and Retrieval, Opinion Spam Detection.

|          |                         |           |
|----------|-------------------------|-----------|
| <b>6</b> | <b>Web Usage Mining</b> | <b>01</b> |
|----------|-------------------------|-----------|

Data Collection and Pre-Processing, Data Modeling for Web Usage Mining, Discovery and Analysis of Web Usage Patterns, Recommender Systems and Collaborative Filtering, Query Log Mining, Computational Advertising.

#### **Books :**

#### **Text:**

1. Bing Liu, "Web Data Mining Exploring Hyperlinks, Contents, and Usage Data", Springer, Second Edition, ISBN 978-3-642-19459-7.
2. Zdravko Markov, Daniel T. Larose "Data Mining the Web: Uncovering Patterns in Web Content, Structure, and Usage", Wiley, 2007, ISBN: 978-0-471-66655-4.

#### **Reference :**

1. Jesus Mena, "Data Mining Your Website", Digital Press, 1999, ISBN: 1-55558-222-2.
2. Soumen Chakrabarti, "Mining the Web: Discovering Knowledge from Hypertext Data", Morgan Kaufmann Publishers, 2002, ISBN-13: 978-1-55860-754-5.
3. Mike Thelwall, "Link Analysis: An Information Science Approach", 2004, Academic Press



| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective II</b><br><b>510111C : Pervasive and Ubiquitous Computing</b>  |   |   |
|--|---|---|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>  | <b>Credit</b><br><b>05</b>                | <b>Examination Scheme:</b><br><b>In-Sem : 50 Marks</b><br><b>End-Sem : 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To understand the characteristics and principles of Pervasive computing</li> <li>To introduce to the enabling technologies of pervasive computing</li> <li>To understand the basic issues and performance requirements of pervasive computing applications</li> <li>To learn the trends of pervasive computing</li> </ul>  |   |   |
| <b>Course Outcomes :</b><br>On completion of the course, student will be able to– <ul style="list-style-type: none"> <li>Design and implement primitive pervasive applications</li> <li>Analyze and estimate the impact of pervasive computing on future computing applications and society</li> <li>Develop skill sets to propose solutions for problems related to pervasive computing system</li> <li>Design a preliminary system to meet desired needs within the constraints of a particular problem space</li> </ul>           |   |   |
| <b>Selection of Modules:</b><br>Kindly note that modules 1, 2 are compulsory and select any three (03) modules from modules 3 to 6.  |   |   |
| <b>Course Contents</b>   |   |   |
| <b>Module No.</b>  | <b>Module Title</b>                       | <b>Credits</b>  |
| <b>1</b>   | <b>Pervasive Computing</b>                | <b>01</b>   |
| 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. Charting Past, Present, and Future Research in Ubiquitous Computing.  |   |   |
| <b>2</b>   | <b>Open protocols</b>                     | <b>01</b>   |
| 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 |   |   |
| <b>3</b>   | <b>Voice Enabling Pervasive Computing</b> | <b>01</b>   |
| Voice Enabling 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.  |                                   |           |
| <b>4</b>  | <b>Personal Digital Assistant</b> | <b>01</b> |
| 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., PinchWatch: A Wearable Device for One-Handed Micro interactions., Interfaces - Enabling mobile micro-interactions with physiological computing.   |                                   |           |
| <b>5</b>  | <b>User Interface</b>             | <b>01</b> |
| User Interface Issues in Pervasive Computing, Architecture, Smart Card- based Authentication Mechanisms , Wearable computing Architecture. Touche: Enhancing Touch Interaction on Humans, Screens, Liquids, and Everyday Objects  |                                   |           |
| <b>6</b>  | <b>Applications</b>               | <b>01</b> |
| Smart Tokens, Heating Ventilation and Air Conditioning, Set Top Boxes, Appliances and Home Networking, Residential Gateway, Automotive Computing, On Board Computing Systems, In Vehicle networks, Entertainment Systems, Emerging Sites of HCI Innovation: Hacker spaces, Hardware Startups & Incubators   |                                   |           |
| <b>Books :</b>  |                                   |           |
| <b>Text :</b>   |                                   |           |
| <ol style="list-style-type: none"> <li>1. Jochen Burkhardt, Horst Henn, Stefan Hepper, Thomas Schaeck &amp; Klaus Rindtorff, “ Pervasive Computing Technology and Architecture of Mobile Internet Applications”, Addison Wesley, Reading, 2002. ISBN:13: 978-0-201-72215-4</li> <li>2. Uwe Hansman, Lothar Merk, Martin S Nicklous &amp; Thomas Stober: Principles of Mobile Computing, Second Edition, Springer- Verlag, New Delhi, 2003, ISBN: 9783662043189</li> </ol>   |                                   |           |
| <b>References :</b>   |                                   |           |
| <ol style="list-style-type: none"> <li>1. Mohammads, Obaidait, Denko, Woungang, “ Pervasive Computing and Networking”, Wiley, ISBN:978-0-470-74772-8</li> <li>2. Seng Loke, “Context-Aware Computing Pervasive Systems”, Auerbach Pub., New York, 2007, ISBN: 978-1-4471-5006-0</li> <li>3. Uwe Hansmann etl , “Pervasive Computing”, Springer, New York,2001., ISBN: 10: 3540002189</li> <li>4. Jochen Burkhardt, , Stefan Hepper, Klaus Rindtorff, Thomas Schaeck “Pervasive Computing-Technology and Architecture of Mobile Internet Application”, Pearson Education, Sixth Edition 2009, ISBN:</li> <li>5. John Krumm, "Ubiquitous Computing Fundamentals", Shroff Publishers, ISBN: 9781420093605 .</li> </ol> |                                   |           |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective II</b><br><b>510111D : Network Security</b>   |   |   |
|---|---|---|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>   | <b>Credit</b><br><b>05</b>                | <b>Examination Scheme:</b><br><b>In Sem :: 50 Marks</b><br><b>End-Sem: 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To understand the concept of security and its applications.</li> <li>To learn various vulnerabilities, threats and attacks</li> <li>To know various detection and prevention techniques in diversified environments</li> <li>To study different algorithms for network security</li> </ul>   |   |   |
| <b>Course Outcomes:</b><br>After completion of the course, students should be able to <ul style="list-style-type: none"> <li>Design and choose appropriate security model</li> <li>Apply security means to various applications</li> <li>Apply security algorithms in various environments for network security</li> <li>Design network security solutions</li> <li>Select appropriate tools to thwart network attacks</li> </ul> |   |   |
| <b>Selection of Modules:</b><br>Kindly note that modules 1, 2 are compulsory and select any three (03) modules from modules 3 to 9.   |   |   |
| <b>Course Contents</b>  |   |   |
| <b>Module No</b>  | <b>Module Title</b>                       | <b>Credit</b>   |
| <b>1</b>  | <b>Classification of Network Attacks</b>  | <b>01</b>   |
| Basic Security Concepts, History of Network Security, Data Security Vs. Network Security, Computer And Network Attacks, Introduction To Vulnerabilities, Threats And Attacks, Layers Of Attacks, Counter Measure Of Different Attacks Counter Measures For Various Attacks Case Study: How To Detect And Prevent Black Hole Attack In Mobile Ad Hoc Network   |   |   |
| <b>2</b>  | <b>WSN attacks</b>                        | <b>01</b>   |
| Review of WSN Attacks. Challenges on Detection of WSN Attacks, Approaches for Securing WSN  |   |   |
| <b>3</b>  | <b>Hacking &amp; Sniffing</b>             | <b>01</b>   |
| Hacking tools, The hacking process, Ethical hacking issues, Current technologies, Recent events and statistics of network attacks, Wi-Fi vulnerabilities<br>What is network sniffing? Why network sniffing is important, Scan a single IP, Scan a host, Scan a range of Ips, Scan a subnet  |   |   |
| <b>4</b>  | <b>Port Scanning and Spoofing</b>         | <b>01</b>   |
| Nmap port selection : Scan a single port, Scan a range of ports, Scan 100 most common ports (fast), Scan all 65535 ports, Scanning a subnet : Spoofing and decoy scans, Evading firewalls<br>Nmap port scan types : Scan using TCP SYN scan (default), Scan using TCP connect   |   |   |
| <b>5</b>  | <b>Browser Exploitation, MITM attacks</b> | <b>01</b>   |

|  |                                |           |
|--|--------------------------------|-----------|
| Gathering version info : UDP scan, The reason switch, Using a list, Output to a file<br>Commands, Starting the listener, Countermeasures, Social Engineering Toolkit and Browser<br>Exploitation: Social engineering , What are web injections? How SQL injections work Cross<br>site scripting (XSS) attacks: Preventative measures against XSS attacks How to reduce your<br>chances of being attacked, Browser exploitation with BeEF : Browser hijacking, BeEF with<br>BetterCap, BeEF with man-in-the-middle framework (MITMF), BeEF with SET |                                |           |
| <b>6</b>   | <b>Advanced Attacks</b>        | <b>01</b> |
| Advanced Network Attacks :What is an MITM attack?Related types of attacks, Examples o<br>MITM, Tools for MITM attacks, Installing MITMF using Kali Linux, Passing and Cracking<br>the Hash, What is a hash? Authentication protocols, Cryptographic hash functions: How do<br>hackers obtain the hash? What tools are used to get the hash? How are hashes cracked? How<br>do pass the hash attacks impact businesses? What defenses are there against hash password<br>attacks?   |                                |           |
| <b>7</b>   | <b>Web Content Attacks</b>     | <b>01</b> |
| SQL Injection: Examples of SQL injection attacks, Ways to defend against SQL injection<br>attacks, Attack vectors for web applications, Bypassing authentication, Bypasses blocked and<br>filtered websites, Finding vulnerabilities from a targeted sites, Extracting data with SQLmap,<br>Hunting for web app vulnerabilities with Open Web Application Security Project (OWASP)<br>ZAP  |                                |           |
| <b>8</b>   | <b>Specialized Attacks</b>     | <b>01</b> |
| Malformed packets: Ping of death, Teardrop attack (aka Nestea), ARP cache poisoning, ARP<br>poisoning commands, ACK scan, TCP port scanning, VLAN hopping, Wireless sniffing, OS<br>fingerprinting ISN Sniffing, Passive OS detection  |                                |           |
| <b>9</b>   | <b>Intrusions and Remedies</b> | <b>01</b> |
| Web application exploits, What tools are used for web application penetration testing?<br>Evil Twins and Spoofing : What is an evil twin? What is address spoofing? What is DNS<br>spoofing? What tools are used for setting up an evil twin? The dangers of public Wi-Fi and<br>evil twins, How to detect an evil twin? Detection Systems : IDS, IPS, Host based, Network-<br>based, Physical Threat hunting platforms  |                                |           |
| <b>Books:</b>  |                                |           |
| <b>Text :</b>  |                                |           |
| <ol style="list-style-type: none"> <li>1. Dileep Kumar G.; Manoj Kumar Singh; M.K. Jayanthi, “Network Security Attacks and Countermeasures”, IGI Global, ISBN-13: 978-1-4666-8761-5</li> <li>2. Arthur Salmon, Warun Levesque, Michael McLafferty, “Applied Network Security”, Packt Publishing, ISBN-13: 978-1-78646-627-3</li> </ol>   |                                |           |
| <b>Reference:</b>  |                                |           |
| <ol style="list-style-type: none"> <li>1. William Stallings, ‘Cryptography and Network Security: Principle and Practice’, 5th Edition, Pearson, ISBN: 978-81-317-6166-3.</li> <li>2. Bernard Menezes, ‘Network Security and Cryptography’, Cengage Learning, ISBN: 978-81-315-1349-1.</li> <li>3. Matt Bishop, Sathyanarayana, S. Venkatramanayya, “ Introduction to Computer Security”, Pearson Education, ISBN: 978-81-7758-425-7.</li> <li>4. Bruce Schneier, “Applied Cryptography”, Wiley, ISBN:978-1-1119-09672-6</li> </ol>                 |                                |           |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>510112 : Seminar I</b>   |                            |  |
|---|----------------------------|--|
| <b>Teaching Scheme:</b><br><b>Practical: 04 Hrs/week</b>  | <b>Credit</b><br><b>04</b> | <b>Examination Scheme:</b><br><b>TW : 50 Marks</b><br><b>Presentation : 50 marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.</li> <li>To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms and services.</li> </ul>   |                            |  |
| <b>Course Outcomes:</b><br>On completion of the course, student will be able– <ul style="list-style-type: none"> <li>To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression,.</li> <li>To acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication.</li> <li>To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across</li> </ul> <p>The student shall have to deliver the seminar I in semester II on a topic approved by guide and authorities. It is recommended to allot guide to the student since the commencement of semester I. The guide allotment preferably needs to be carried out in synchronization with mutual domains of interest. It is recommended that seminar shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected or domain of interest.</p> <p>It is appreciated and strongly recommended that the student will select the domain of his/her dissertation and identify the literature confined to the domain. Thorough literature study based on the broad identified topic has to be carried out. This practice will eventually lead to convergence of the efforts for the dissertation in Semester III and IV.</p> <p>The relevant literature then be explored as state-of-the-art, exotic, recent technological advancement, future trend, application and research &amp; innovation. Multidisciplinary topics are encouraged. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.</p> <p>The students are expected to validate their study undertaken by publishing it at standard platforms.</p> <p>The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.</p> <p>The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in seminar logbook approved by Board of Studies.</p> |                            |  |

|   |  |  |
|---|--|--|
| <p align="center"><b>Savitribai Phule Pune University</b><br/> <b>Master of Computer Engineering (2017 Course)</b><br/> <b>510113 : Laboratory Proficiency II</b></p>   |  |  |
| <b>Teaching Scheme:</b><br><b>Practical: 08 Hrs/week</b>  | <b>Credit</b><br><b>04</b>   | <b>Examination Scheme:</b><br><b>Presentation: 50 Marks</b><br><b>TW: 50 Marks</b> |
| <p>Laboratory Proficiency II (LP II) is companion course of theory courses (core and elective) in Semester II. It is recommended that set of assignments or at least one mini-project/study project per course is to be completed. Set of problem statements is suggested. Course/ Laboratory instructor may frame suitable problem statements. Student has to submit a report/Journal consisting of appropriate documents - prologue, Certificate, table of contents, and other suitable write up like (Introduction, motivation, aim and objectives, outcomes, brief theory, requirements analysis, design aspects, algorithms, mathematical model, complexity analysis, results, analysis, and conclusions). Softcopy of report /journal and code is to be maintained at department/institute in digital repository.</p> |  |  |
| <p align="center"><b>Suitable platform/framework/language is to be used for completing mini-project/assignments.</b></p>  |  |  |
| <p align="center"><b>Guidelines for Term Work Assessment</b></p>  |  |  |
| <p>Continuous assessment of laboratory work is done based on performance of student. Each assignment/ mini project assessment to be done based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as mini project assessment include- timely completion, performance, innovation, efficient codes, usability, documentation and adhering to SDLC comprehensively.</p>  |  |  |
| <p align="center"><b>Guidelines for Examination</b></p>   |  |  |
| <p>It is recommended that examination should be conducted as presentation by student based on one of the mini projects completed and the content understanding of laboratory work.</p>  |  |  |
| <p align="center"><b>Suggested List of Laboratory Assignments</b></p>   |  |  |
| <p align="center"><b>A. Operations Research</b></p>   |  |  |
| <p><b>1. The Transportation Problem:</b></p>  | <p>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:</p> |  |

| 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                                | Opportunity |     |     |     |     |     |     |     |
| Invested (\$10 million)               | 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 |

## B. System Simulation & Modeling

### 1. Using suitable simulation Tool simulate any one of-

#### A. Automobile Manufacturing Model-

The automobile has changed life of man in a way unimaginable before its invention. "The world travels on wheels" is the buzzword of the 20th century. The manufacturing of these automobiles is both a fascinating and challenging task. The simulation team has simulated the manufacturing process of wagons, sedans and convertibles in a Toyota car plant



|                            |  |
|----------------------------|--|
|                            | <p>The following is the step by step procedure for the manufacturing of cars in the "Toyota Production System":</p> <ol style="list-style-type: none"> <li>1. The manufacturing process begins with the chassis assembly. The chassis is the skeleton of the car. It is the part on which the car is built.</li> <li>2. Axle and tires are fitted to the chassis assembly.</li> <li>3. In the next stage, the engine is fitted to the chassis. The engine is the power-producing component of the car. The power produced in the engine is use to propel the car. Engines are mostly of the internal combustion type.</li> <li>4. The gearbox is then fitted into the chassis. The gearbox is the component that is used to change the speed supplied to the wheels.</li> <li>5. The next stage involves the fitting of the radiator into the engine. The radiator helps in cooling the engine, transmitting the excess heat to the surrounding by conduction.</li> <li>6. The seats are then fitted to the car in the next stage.</li> <li>7. The battery is then fitted and electrical connections are carried out. The electrical connections connect the various components of the car to the battery.</li> <li>8. The body of the car is then fitted on the chassis.</li> <li>9. The windshield, doors, and wipers are fitted to the car along with the bonnet.</li> <li>10. The finishing touches are carried out on the car.</li> <li>11. The car is then sent for inspection and testing after which it is taken to the parking lot and kept ready for shipping.</li> </ol> <p><b>B. Simulation of Inventory Control System</b><br/> <b>C. Simulation of Single Server queuing system</b><br/> <b>D. Customer Queuing System</b><br/> <b>E. Transportation Model</b></p> |
| <b>C. Machine Learning</b> |  |
|                            | <p>The laboratory course teacher has to design the assignment based on the data analysis of the data confined to any of the following domains or similar, <b><u>Students need to use R and Python for the assignment</u></b></p> <p>The machine learning algorithms need to be applied to these data. For example if it is the Email data, then the student has to perform following operations,</p> <ul style="list-style-type: none"> <li>• Based on the occurrence of certain key words like lottery, tonic. the designed spam filter will build the information indicating TP,TN,FP and FN.</li> <li>• The system will plot coverage and ROC plots</li> <li>• The system will plot the scoring tree, ranking tree and grading classifier</li> <li>• Depending on the urgency to reply the email will be regressed on the scale of 1 to 10</li> <li>• Plot the regression graph and use appropriate clustering algorithm and plot the results</li> </ul> <p><b>Other sample statements may be as below-</b></p>   |
| <b>1</b>                   | <p><b>Suspicious activity detection from CCTVs :</b> Use machine learning to make the society a safer place. The idea is to have a machine learning algorithm capturing and analyzing the CCTV video all the time and learn from it the normal activities of people like walking, running. so that if any suspicious activity occurs, say robbery, it alerts the authorities in real time about the incident.</p>  |

|   |   |
|---|---|
| <b>2</b>  | <b>Medical diagnostics for detecting diseases :</b> Doctors and hospitals are now increasingly getting assisted in detecting diseases like skin cancer faster and more accurately. A system designed by IBM correctly picked the cancerous lesions(damage) in the images with 95% accuracy where a doctor's accuracy is usually between 75% - 84% using manual methods. So, the computing approach will help the doctors make more informed decisions by increasing the efficiency to recognise melanoma and spot the cases where it is difficult for the doctors to identify.  |
| <b>3</b>  | <b>Web Search and Recommendation Engines:</b> <ul style="list-style-type: none"> <li>find recognize input, find relevant searches, predict which results are most relevant to us, return a ranked output</li> <li>recommend similar products (e.g., Netflix, Amazon,)</li> </ul>  |
| <b>4</b>  | <b>Finance:</b> <ul style="list-style-type: none"> <li>predict if an applicant is credit-worthy</li> <li>detect credit card fraud</li> <li>find promising trends on the stock market</li> </ul>   |
| <b>5</b>  | <b>Text and Speech Recognition:</b> <ul style="list-style-type: none"> <li>handwritten digit and letter recognition at the post office</li> <li>voice assistants (Siri)</li> <li>language translation service</li> </ul>  |
| <b>6</b>  | <b>Social Networks and Advertisement:</b> <ul style="list-style-type: none"> <li>data mining of personal information</li> <li>selecting relevant ads to show</li> </ul>   |
| <b>7</b>  | <b>Other:</b> <ul style="list-style-type: none"> <li>Web page classification: various spam and junk pages, like soft404, parked domain</li> <li>Entity extraction from web page and queries, like names, addresses.</li> <li>Speller correction, running on each queries into Bing.</li> <li>Search ranking, optimize for NDCG.</li> <li>Facebook Ads ranking: various events prediction, like CTR, negative feedback, conversion. It serves <math>\sim 10^{10}</math> page views daily.</li> <li>Facebook news feed ranking, with daily <math>\sim 10^{11}</math> impression.</li> <li>Facebook PYMK (People You Might Know), aka friend suggestions.</li> </ul> |
| <b>D. Elective II</b>   |   |
| Course instructor is authorized to frame suitable problem statement for Assignments/ mini project |   |

# Semester III

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>610101 :Fault Tolerant Systems</b>   |   |   |
|---|---|---|
| <b>Teaching Scheme:</b><br><b>TH: 04 Hours/Week</b>   | <b>Credit</b><br><b>04</b>  | <b>Examination Scheme:</b><br><b>In-Sem : 50 Marks</b><br><b>End-Sem : 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To identify and understand the need of redundancies in the systems</li> <li>To understand reliability and accountability in the systems</li> <li>To know the instances where fault tolerance is inevitable</li> <li>To understand the concept of fault tolerance in detail</li> </ul>   |   |   |
| <b>Course Outcomes :</b><br>On completion of the course the student should be able to- <ul style="list-style-type: none"> <li>Analyze the system for the requirement of fault tolerance</li> <li>Simulate the fault tolerance algorithms</li> <li>Implement diagnosis and recovery of the system</li> <li>Assess the reliability of the system</li> </ul> |   |   |
| <b>Course Contents</b>  |   |   |
| <b>Unit I</b>   | <b>Fault Tolerance and Reliability Analysis</b>                                 | <b>08 Hours</b>   |
| Introduction, Redundancy Techniques- Hardware Redundancy, Software Redundancy, Information Redundancy, Time Redundancy, Reliability Modeling and Evaluation - Empirical Models, Analytical Techniques.  |   |   |
| <b>Unit II</b>  | <b>Fault Modeling, Simulation and Diagnosis</b>                                 | <b>08 Hours</b>   |
| Fault Modeling, Fault Simulation, Fault Simulation Algorithms- Serial Fault Simulation Algorithm, Parallel Fault Simulation, Deductive Fault Simulation, Concurrent Fault Simulation, Critical Path Tracing, Fault Diagnosis- Combinational Fault Diagnosis, Sequential Fault Diagnosis Methods.  |   |   |
| <b>Unit III</b>   | <b>Fault-Tolerant Routing in Multi-Computer Networks</b>                        | <b>08 Hours</b>   |
| Fault-Tolerant Routing Algorithms in Hypercube- Depth-First Search Approach, Iterative-Based Heuristic Routing Algorithm, Routing in Faulty Mesh Networks- Node Labeling Technique, A FT Routing Scheme for Meshes with Non-convex Faults.  |   |   |
| <b>Unit IV</b>  | <b>Fault Tolerance and Reliability in Hierarchical Interconnection Networks</b> | <b>08 Hours</b>   |
| Block-Shift Network (BSN)- BSN Edges Groups, BSN Construction, BSN Degree and Diameter, BSN Connectivity, BSN Fault Diameter, BSN Reliability, Hierarchical Cubic Network (HCN)- HCN Degree and Diameter, HINs versus HCNs, The Hyper-Torus Network (HTN).  |   |   |
| <b>Unit V</b>   | <b>Fault Tolerance and Reliability of Computer Networks</b>                     | <b>08 Hours</b>   |
| Fault Tolerance in Loop Networks - Reliability of Token-Ring Networks, Reliability of Bypass-Switch Networks, Double Loop Architectures, Multi-Drop Architectures, Daisy-Chain  |   |   |

|   |  |                 |
|---|--|-----------------|
| Architectures, Fault Tolerance in High Speed Switching Networks - Classification of Fault-Tolerant Switching Architectures, Architecture-Dependent Fault Tolerance.   |  |                 |
| <b>Unit VI</b>  | <b>Fault Tolerance in Distributed System and Mobile Networks</b> | <b>08 Hours</b> |
| Faults, Errors and Failures, failure models, process resilience, reliable client-server communication, reliable group communication, Check pointing Techniques in Mobile Networks- Minimal Snapshot Collection Algorithm, Mutable Checkpoints, Adaptive Recovery, Message Logging Based Checkpoints, Hybrid Checkpoints.  |  |                 |
| <b>Books:</b>   |  |                 |
| <b>Text:</b>  |  |                 |
| <ol style="list-style-type: none"> <li>1. Mostafa Abd-El-Barr, “Design and Analysis of Reliable and Fault-Tolerant Computer Systems” , World Scientific Publishing , ISBN 1281867497</li> <li>2. Andrew Tanenbaum, “Distributed Systems Principles and Paradigms”, Pearson Prentice Hall, ISBN: 978-15-302817-5-6</li> </ol>  |  |                 |
| <b>Reference:</b>   |  |                 |
| <ol style="list-style-type: none"> <li>2. Dhiraj K. Pradhan, “ Fault Tolerant Computer System Design”, Prentice Hall, ISBN-13: 978-0130578877</li> <li>3. Martin L. Shooman, “Reliability of Computer Systems and Networks: Fault Tolerance”, ISBN: 471464066</li> <li>4. Jan Vytöpil, “Formal Techniques in Real-Time and Fault-Tolerant Systems“, ISBN: 1461532205</li> </ol> |  |                 |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>610102: Information Retrieval</b>   |  |  |
|--|--|--|
| <b>Teaching Scheme:</b><br><b>TH: 04 Hours/Week</b>  | <b>Credit</b><br><b>04</b>                                   | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem : 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To study concepts of Information Retrieval;</li> <li>To understand the data in the form of XML</li> <li>To study and Evaluate retrieved information</li> <li>To understand classification and clustering</li> </ul>   |  |  |
| <b>Course Outcomes:</b><br>On completion of the course the student should be able to- <ul style="list-style-type: none"> <li>Implement the concept of Information Retrieval</li> <li>Evaluate and Analyze retrieved information</li> <li>Generate quality information out of retrieved information</li> <li>Apply clustering and classification algorithms to analyze the information</li> </ul>   |  |  |
| <b>Course Contents</b>   |  |  |
| <b>Unit I</b>  | <b>Dictionaries and tolerant retrieval</b>                   | <b>08 Hours</b>  |
| Search structures for dictionaries, <b>Wildcard queries</b> :General wildcard queries ,k-gram indexes for wildcard queries, <b>Spelling correction</b> : Implementing spelling correction, Forms of spelling correction, Edit distance, k-gram indexes for spelling correction, Context sensitive spelling correction, Phonetic correction   |  |  |
| <b>Unit II</b>   | <b>Index Construction index compression scoring</b>          | <b>08 Hours</b>  |
| . Index compression, Searching, Sequential Searching and Pattern Matching, Hardware basics, Types of indexes, <b>Statistical properties of terms in information retrieval</b> : Heaps' law: Estimating the number of terms, <b>Zipf's law</b> : Modeling the distribution of terms, <b>Dictionary compression</b> : Dictionary as a string ,Blocked storage, <b>Postings file compression</b> :Variable byte codes, Gamma codes.                           |  |  |
| <b>Unit III</b>  | <b>Scoring, term weighting &amp; the vector space model:</b> | <b>08 Hours</b>  |
| <b>Parametric and zone indexes</b> : Weighted zone scoring, Learning weights, The optimal weighting, <b>Term frequency and weighting</b> : Inverse document frequency, Tf- idf weighting, <b>The vector space model for scoring</b> :Dot products, Queries as vectors, Computing vector scores, <b>Variant tf-idf functions</b> : Sub-linear tf scaling Maximum tf normalization, Document and query weighting schemes, Pivoted normalized document length |  |  |
| <b>Unit IV</b>   | <b>XML Retrieval</b>   | <b>08 Hours</b>  |
| Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-Centric vs. Data-Centric XML retrieval. Language models for information retrieval, Language models, The query likelihood model, Language modeling versus other approaches in IR, Extended language modeling approaches.   |  |  |

| Unit V   | Language models for information retrieval | 08 Hours |
|--|---|----------|
| <b>Language models:</b> Finite automata and language models, Types of language models, Multinomial distributions over words, <b>The query likelihood model:</b> Using query likelihood language models in IR ,Estimating the query generation probability ,Ponte and Croft's Experiments , Language modeling versus other approaches in IR ,Extended language modeling approaches.   |   |          |
| Unit VI  | Classification & clustering searches      | 08 Hours |
| Text Classification and Naïve Bayes ,Vector Space Classification, Support vector machines, and Machine learning on documents. Flat Clustering , Hierarchical Clustering ,Matrix decompositions and latent semantic indexing ,Fusion and Meta learning, Searching the Web Structure of the Web IR and web search  |   |          |
| <b>Books :</b>   |   |          |
| <b>Text</b> <ol style="list-style-type: none"> <li>1. C. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval" , Cambridge University Press, 2008, -13: 9780521865715</li> <li>2. Ricardo Baeza -Yates and Berthier Ribeiro – Neto, "Modern Information Retrieval: The Concepts and Technology behind Search" 2nd Edition, ACM Press Books 2011.</li> <li>3. Bruce Croft, Donald Metzler and Trevor Strohman, Search Engines: Information Retrieval in Practice, 1st Edition Addison Wesley, 2009, ISBN: 9780135756324.</li> </ol>   |   |          |
| <b>Reference :</b> <ol style="list-style-type: none"> <li>1. S. Buttcher, C. Clarke and G. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines", MIT Press, 2010, ISBN: 0-408-70929-4.</li> <li>2. C.J. Rijsbergen, "Information Retrieval", (<a href="http://www.dcs.gla.ac.uk/Keith/Preface.html">http://www.dcs.gla.ac.uk/Keith/Preface.html</a>)</li> <li>3. W.R. Hersh, "Information Retrieval: A Health and Biomedical Perspective", Springer, 2002.</li> <li>4. G. Kowalski, M.T. Maybury. "Information storage and Retrieval System" , Springer, 2005</li> <li>5. W.B. Croft, J. Lafferty, "Language Modeling for Information Retrieval", Springer, 2003.</li> </ol> |   |          |



|  |                                    |  |
|--|------------------------------------|--|
| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective III</b><br><b>610103A : Cloud Security</b>   |                                    |  |
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>  | <b>Credit</b><br><b>05</b>         | <b>Examination Scheme:</b><br><b>In- Sem: 50 Marks</b><br><b>End- Sem : 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To study concepts of Cloud Computing;</li> <li>• To learn and Explore Cloud Infrastructures</li> <li>• To study cloud Security Fundamentals</li> <li>• To know various issues related to the security of information in cloud environment</li> </ul>  |                                    |  |
| <b>Course Outcomes:</b> <ul style="list-style-type: none"> <li>• Use various services offered for cloud environment</li> <li>• Apply computing security fundamentals confined to cloud environment</li> <li>• Analyze the cloud system for vulnerabilities, threats and attacks</li> <li>• Propose feasible security solution for cloud security</li> </ul>  |                                    |  |
| <b>Course Contents</b>   |                                    |  |
| <b>Selection of Modules:</b> Module 1 is compulsory and select any four(04) modules from 2 to 7.   |                                    |  |
| <b>Module No.</b>  | <b>Module Title</b>                | <b>Credit</b>  |
| <b>1</b>   | <b>Introduction</b>                | <b>01</b>  |
| Cloud Computing Fundamentals, Essential Characteristics, Architectural Influences, Technological Influences, Operational Influences, Outsourcing, IT Service Management, Cloud Computing Architecture, Cloud Delivery Models, Cloud Deployment Models, Alternative Deployment Models, Expected Benefits.<br>Understanding Abstraction and Virtualization, Capacity Planning, Exploring Platform as a Service, Using Google Web Services, Using Amazon Web Services, Using Microsoft Cloud Services.  |                                    |  |
| <b>2</b>   | <b>Cloud Security</b>              | <b>01</b>  |
| Cloud Information Security Objectives, Confidentiality, Integrity, and Availability, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements, Approaches to Cloud Software Requirements Engineering, Cloud Security Policy Implementation and Decomposition, Secure Cloud Software Testing, Testing for Security Quality Assurance, Cloud Penetration Testing, Regression Testing, Cloud Computing and Business Continuity Planning/Disaster Recovery |                                    |  |
| <b>3</b>   | <b>Cloud Computing Risk Issues</b> | <b>01</b>  |
| The CIA Triad, Privacy and Compliance Risks, Threats to Infrastructure, Data, and Access Control, Common Threats and Vulnerabilities, Cloud Access Control Issues, Cloud Service Provider Risks, Cloud Computing Security Challenges, Security Policy Implementation, Policy Types, Computer Security Incident Response Team (CSIRT), Virtualization Security Management.  |                                    |  |

|   |  |           |
|---|--|-----------|
| <b>4</b>  | <b>Cloud Computing Security Architecture</b> | <b>01</b> |
| Architectural Considerations, General Issues, Trusted Cloud Computing, Secure Execution Environments and Communications, Identity Management and Access Control, Identity Management, Access Control, Autonomic Security.   |  |           |
| <b>5</b>  | <b>Cloud Computing Life Cycle Issues</b>     | <b>01</b> |
| Standards, The Distributed Management Task Force (DMTF), The International Organization for Standardization (ISO), The European Telecommunications Standards Institute (ETSI), The Organization for the Advancement of Structured Information Standards (OASIS), Storage Networking Industry Association (SNIA), Open Grid Forum (OGF), The Open Web Application Security Project (OWASP), Incident Response, Encryption and Key Management, VM Architecture, Retirement      |  |           |
| <b>6</b>  | <b>Cloud storage Security</b>                | <b>01</b> |
| Who wants your data? Legal issues, criminals and authorization. Government and friends, legal responsibility, US Federal Law and regulations affecting cloud storage. Cloud storage provider and compliance. Laws and regulations of other countries.   |  |           |
| <b>7</b>  | <b>Privacy Tools and Best Practices</b>      | <b>01</b> |
| Privacy Tools and Best Practices, 2-factor authentication, secure email for cloud storage, Deletion of private data, security as service, distributed cloud storage, what are best practices, cloud data security and check list, Future of cloud data security.  |  |           |
| <b>Books:</b>   |  |           |
| <ol style="list-style-type: none"> <li>1. Tim Mather, Shahed Latif, Subra Kumaraswamy, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'Reilly Media, SBN-13: 978-0596802769, ISBN-10: 0596802765</li> <li>2. Ronald L Krutz and Russell Dean Vines , "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", ISBN:0470938943</li> </ol>   |  |           |
| <b>References:</b>  |  |           |
| <ol style="list-style-type: none"> <li>1. Vic (J.R.) Winkler , "Securing the Cloud: Cloud Computer Security Techniques and Tactics", ISBN:159749593X</li> <li>2. Imad M. Abbadi, "Cloud Management and Security", ISBN: 1118817079</li> <li>3. Sumner Blount, Rob Zanella, "Cloud Security and Governance: Who's on Your Cloud?", ISBN: 1849280908</li> <li>4. Ryan Ko, Raymond Choo, "The Cloud Security Ecosystem: Technical, Legal, Business", ISBN: 0128017805</li> </ol> |  |           |

**Savitribai Phule Pune University**  
**Master of Computer Network Engineering (2017 Course)**  
**Elective III**  
**610103B : Speech Signal Processing**

**Teaching Scheme:**  
**TH: 05 Hours/Week**

**Credit**  
**05**

**Examination Scheme:**  
**In-Sem: 50 Marks**  
**End-Sem: 50 Marks**

**Course Objectives:**

- To understand basic characteristics of speech signal
- To learn speech signal production and hearing of speech by humans
- To be familiar with the techniques for the analysis of speech signals
- To understand different speech modeling procedures
- To know the applications of speech signal processing

**Course Outcomes:**

- Inculcate the characteristics of speech signal in relation to production and hearing of speech by humans
- Apply various algorithms of speech analysis common to many applications
- The students will be able to design a simple system for speech processing
- Analyze the performance of speech signal processing system

**Selection of Modules:**

Kindly note that modules 1, 2, 3 are compulsory and select any two (02) modules from modules 4-8.

**Course Contents**

| <b>Module No.</b>  | <b>Module Title</b>                              | <b>Credit</b> |
|--|--|---------------|
| <b>1</b>   | <b>Basic Concepts</b>                            | <b>01</b>     |
| Introduction, mechanism of speech production. Articulatory Phonetics – Production and Classification of Speech Sounds Acoustic phonetics: vowels, diphthongs, semivowels, nasals, fricatives, stops and affricates.; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.  |  |               |
| <b>2</b>   | <b>Speech Analysis</b>                           | <b>01</b>     |
| Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures—mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths. |  |               |
| <b>3</b>   | <b>Speech Modeling</b>                           | <b>01</b>     |
| Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.   |  |               |
| <b>4</b>   | <b>Applications of Speech Processing</b>         | <b>01</b>     |
| Brief applications of speech processing in voice response systems, hearing aid design and recognition system.  |  |               |
| <b>5</b>   | <b>Statistical Models for Speech Recognition</b> | <b>01</b>     |
| (i) Vector quantization models and applications in speaker recognition. (ii) Gaussian mixture modeling for speaker and speech recognition. (iii) Discrete and Continuous Hidden Markov modeling for isolated word and continuous speech recognition.   |  |               |

|  |   |           |
|--|---|-----------|
| <b>6</b>   | <b>Speech Recognition</b>                   | <b>01</b> |
| Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent sub-word Units; Applications and present status.  |   |           |
| <b>7</b>   | <b>Speech Synthesis</b>                     | <b>01</b> |
| Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word Units for TTS, intelligibility and naturalness – role of prosody, Applications and present  |   |           |
| <b>8</b>   | <b>Linear Predictive Analysis of Speech</b> | <b>01</b> |
| Formulation of Linear Prediction problem in Time Domain-Basic Principle, Auto correlation method, Covariance method, Solution of LPC equations, Cholesky method, Durbin's recursive algorithm, lattice formation and solutions, comparison of different VELP, CELP   |   |           |
| <b>Books:</b>  |   |           |
| <b>Text:</b>   |   |           |
| <ol style="list-style-type: none"> <li>1. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Edu, 2003.</li> <li>2. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999, isbn: 13: 978-0471977308</li> <li>3. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2002.</li> </ol>  |   |           |
| <b>References:</b>   |   |           |
| <ol style="list-style-type: none"> <li>1. Steven W. Smith, "The Scientist and Engineer's Guide to Digital Signal Processing", California Technical Publishing, 1997. ISBN:0-9660176-4-1</li> <li>2. Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson Education, 2004, ISBN: 9788129703187.</li> <li>3. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006, ISBN: 10: 8126508221</li> <li>4. UdoZolzer, " Digital Audio Signal Processing", Second Edition, John Wiley &amp; sons Ltd, ISBN: 9780470680018</li> <li>5. Lawrence R. Rabiner and R. W. Schaffer," Digital Processing of Speech Signals", Prentice Hall – 1978, ISBN: 0-13-213603-1</li> <li>6. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1997.</li> </ol> |   |           |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective III</b><br><b>610103C :Mobile Ad-hoc Networks</b>  |                                 |   |
|--|---------------------------------|---|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>  | <b>Credit</b><br><b>05</b>      | <b>Examination Scheme:</b><br><b>In-Sem : 50 Marks</b><br><b>End-Sem : 50 Marks</b> |
| <b>Course Objectives :</b> <ul style="list-style-type: none"> <li>To study the concepts of Ad hoc Networks</li> <li>To learn the concepts of Mobility and Mobility Prediction</li> <li>To understand the functionalities of various Protocols in MANET</li> <li>To know the technological advancements in wireless networks</li> </ul>   |                                 |   |
| <b>Course Outcomes :</b> <ul style="list-style-type: none"> <li>Assess Quality of Service in MANET</li> <li>Evaluate the performance of various Protocols in MANET</li> <li>Choose appropriate constituents and parameters to build MANET</li> <li>Analyze the performance of MANET</li> </ul>   |                                 |   |
| <b>Selection of Modules:</b><br><b>Note that</b> modules 1, 2, 3 are compulsory and select any two (02) from modules 4 to 8.   |                                 |   |
| <b>Course Contents</b>   |                                 |   |
| <b>Module No.</b>  | <b>Module Title</b>             | <b>Credit</b>   |
| <b>1</b>   | <b>Introduction</b>             | <b>01</b>   |
| Fundamentals of Wireless Communication, Characteristics of Wireless channel, IEEE 802 Networking Standard, 802.3, 803.11, 802.15, 802.16, HIPERLAN Standard, HIPERACCESS, Wireless Internet, TCP in Wireless Domain, WAP, ADHOC Wireless Network, Issues in ADHOC Wireless Network.<br><b>Recent Advances in Wireless Networks:</b> Ultra Wide-Band Radio Communication, Wireless Fidelity, Optical Wireless Networks, Multimode 802.11, Meghadoot Architecture. |                                 |   |
| <b>2</b>   | <b>MAC Protocols</b>            | <b>01</b>   |
| Design issues, goals and classification. Contention based protocols, Contention based protocols with reservation mechanisms, scheduling mechanisms, protocols using directional antennas, other protocols. Routing Protocols: Design Issues, Classification, Table Driven, On-Demand, Hybrid, Efficient Flooding Mechanism, Hierarchical, Power-Aware Routing Protocols.   |                                 |   |
| <b>3</b>   | <b>Multicast Routing</b>        | <b>01</b>   |
| Design Issues, Architecture Reference Model, Classification, Tree-Based, Mesh-Based, Energy Efficient, Application Dependent, Multicasting with QOS-Guarantees. Transport layer: Design Issues and Design Goals, Classification, TCP over Ad Hoc Networks, Transport Layer protocols. Network Security Attacks, Key Management, Secure Routing.  |                                 |   |
| <b>4</b>   | <b>Quality of Service</b>       | <b>01</b>   |
| Issues and Challenges, Classification, MAC Layer Solutions, Network Layer Solutions, QOS Frame work. Energy Management: Need, Classification, Schemes for: Battery Management, Transmission Power Management, System Power Management.   |                                 |   |
| <b>5</b>   | <b>Wireless Sensor Networks</b> | <b>01</b>   |

|   |  |           |
|---|--|-----------|
| Introduction, Sensor network Architecture, Data Dissemination, Data Gathering, MAC Protocols for WSN, Quality of WSN. Hybrid Wireless Networks: Introduction, Next Generation Hybrid Wireless Architectures, Routing, Pricing in Multi-hop Wireless Network, Power Control Schemes, Load Balancing.   |  |           |
| <b>6</b>  | <b>Algorithms for Mobile Ad-hoc Networks</b>                       | <b>01</b> |
| Hierarchical routing and clustering, routing with virtual coordinates, relative location determination, overview and classification of NWB algorithms, Robustness control, NWB robustness solutions.  |  |           |
| <b>7</b>  | <b>Encoding for Data Distribution&amp; Power Control Protocols</b> | <b>01</b> |
| Erasure codes, Network coding, Design principles for power control, single layer approach, the systematic approach, energy oriented perspective.  |  |           |
| <b>8</b>  | <b>Vehicular Ad-hoc Networks</b>                                   | <b>01</b> |
| VANET, characteristics, Connectivity, Dynamic transmission range assignment, routing applications, vehicle mobility, VANET vs MANET.  |  |           |
| <b>Books:</b>   |  |           |
| <b>Text:</b>  |  |           |
| <ol style="list-style-type: none"> <li>1. C. Siva Ram Murthy and B.S. Manoj, "Ad hoc Wireless Networks Architectures and protocols", 2nd edition, Pearson Education. 2007, ISBN: 9788131706886, 8131706885</li> <li>2. Charles E. Perkins, "Ad hoc Networking", Addison–Wesley, 2000, ISBN: 0201309769</li> </ol>   |  |           |
| <b>Reference:</b>   |  |           |
| <ol style="list-style-type: none"> <li>1. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, "Mobile ad hoc networking", Wiley-IEEE press, 2004, ISBN: 978-0-471-65688-3.</li> <li>2. Mohammad Ilyas, "The handbook of ad hoc wireless networks", CRC press, 2002, ISBN: 0-8493-1332-5</li> <li>3. T. Camp, J. Boleng, and V. Davies "A Survey of Mobility Models for Ad Hoc Network Research", Wireless Communication. and Mobile Comp., Special Issue on Mobile Ad Hoc Networking Research, Trends and Applications, vol. 2, no. 5, 2002, pp. 483–502, ISBN:</li> <li>4. Fekri M. Abduljalil, "A survey of integrating IP mobility protocols and Mobile Ad hoc networks", ISBN: 10 : 0750675993</li> </ol> |  |           |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>Elective III</b><br><b>610103 D : Pattern Recognition</b>  |  |   |
|---|--|---|
| <b>Teaching Scheme:</b><br><b>TH: 05 Hours/Week</b>   | <b>Credit</b><br><b>05</b>                           | <b>Examination Scheme:</b><br><b>In-Sem : 50 Marks</b><br><b>End- Sem: 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To learn the basic concept of Pattern recognition</li> <li>To study different approaches of pattern recognition</li> <li>To learn various pattern classification techniques</li> <li>To survey on recent advances and applications in pattern recognition</li> </ul>   |  |   |
| <b>Course Outcomes:</b><br>On completion of the course, student will be able to- <ul style="list-style-type: none"> <li>Analyze various type of pattern recognition techniques</li> <li>Identify and apply various pattern recognition and classification approaches to solve the problems</li> <li>Evaluate statistical and structural pattern recognition</li> <li>Percept recent advances in pattern recognition confined to various applications</li> </ul> |  |   |
| <b>Selection of Modules:</b><br>Kindly note that modules 1,2,3 and module 9 are compulsory and select any two (02) modules from remaining modules.  |  |   |
| <b>Course Contents</b>  |  |   |
| <b>Module No.</b>   | <b>Module Title</b>                                  | <b>Credit</b>   |
| <b>1</b>  | <b>Pattern Recognition</b>                           | <b>01</b>   |
| Introduction of Pattern Recognition with its application, Pattern Recognition system, Design cycle of pattern recognition, Learning and adaption, Representation of Patterns and classes, Feature Extraction, pattern recognition models/approaches.  |  |   |
| <b>2</b>  | <b>Error Estimation</b>                              | <b>01</b>   |
| Introduction, Error estimation methods, various distance measures (Euclidean, Manhattan, cosine, Mahalanobis) and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve.  |  |   |
| <b>3</b>  | <b>Decision Theory</b>                               | <b>01</b>   |
| Introduction, Bayesian decision theory-continuous and discrete features, two- category classification, minimum error rate classification, discriminant functions, Parametric Techniques:- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics; Problems of dimensionality. Non-Parametric Techniques:-Density estimation, Parzen Window, Metrics and Nearest-Neighbor classification; Fuzzy classification.                     |  |   |
| <b>4</b>  | <b>Non Metric and structural pattern recognition</b> | <b>01</b>   |



**Tree Classifiers**-Decision Trees, Random Forests, **Structural Pattern recognition:** Elements of formal grammars ,String generation as pattern description ,Recognition of syntactic description ,Parsing ,Stochastic grammars and applications ,Graph based structural representation, **Stochastic method:** Boltzmann Learning.

|          |                   |           |
|----------|-------------------|-----------|
| <b>5</b> | <b>Clustering</b> | <b>01</b> |
|----------|-------------------|-----------|

Introduction, Hierarchical Clustering, agglomerative clustering algorithm, the single linkage, complete, linkage and average, linkage algorithm. Ward's method ,Partition clustering, , K-means algorithm, clustering algorithms based on graph theory(Minimum spanning tree algorithm),Optimization methods used in clustering: clustering using simulating Annealing.

|          |                          |           |
|----------|--------------------------|-----------|
| <b>6</b> | <b>Template Matching</b> | <b>01</b> |
|----------|--------------------------|-----------|

Measures based on Optimal Path Searching techniques: Bellman's optimality principle and dynamic programming, The Edit distance, Dynamic time Warping, Measures based on correlations, Deformable template models

|          |                              |           |
|----------|------------------------------|-----------|
| <b>7</b> | <b>Unsupervised Learning</b> | <b>01</b> |
|----------|------------------------------|-----------|

Neural network structures for pattern recognition, Unsupervised learning in neural pattern recognition , deep learning ,Self-organizing networks

|          |  |           |
|----------|--|-----------|
| <b>8</b> | <b>Fuzzy Logic and Pattern Recognition</b> | <b>01</b> |
|----------|--|-----------|

Fuzzy logic ,Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms

|          |                     |  |
|----------|---------------------|--|
| <b>9</b> | <b>Applications</b> |  |
|----------|---------------------|--|

Pattern recognition applications: Application of pattern recognition techniques in object recognition, biometric, facial recognition, IRIS scanner, Finger prints, 3D object recognition.

#### **Books:**

#### **Text :**

1. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern Classification", 2nd Edition, Wiley-Inter- science, John Wiley & Sons, 2001
2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4<sup>th</sup> Edition, Elsevier, Academic Press, ISBN: 978-1-59749-272-0
3. B.D. Ripley, "Pattern Recognition and Neural Networks", Cambridge University Press. ISBN 0 521 46086 7

#### **Reference :**

1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. David G. Stork and Elad Yom-Tov, "Computer Manual in MATLAB to accompany Pattern Classification", Wiley Inter-science, 2004, ISBN-10: 0471429775
3. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", PHI, ISBN-978- 81-203-4091-6
4. eMedia at NPTEL : <http://nptel.ac.in/courses/106108057/33>

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>610104 : Seminar II</b>   |                            |  |
|--|----------------------------|--|
| <b>Teaching Scheme:</b><br><b>Practical: 4 Hrs/week</b>  | <b>Credit</b><br><b>04</b> | <b>Examination Scheme:</b><br><b>TW: 50 Marks</b><br><b>Presentation: 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.</li> <li>To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms, services.</li> </ul>   |                            |  |
| <b>Course Outcomes:</b><br>On completion of the course, student will be able – <ul style="list-style-type: none"> <li>To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression,.</li> <li>To acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication.</li> <li>To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across</li> </ul>   |                            |  |
| <p>The student shall have to deliver the seminar II in semester III on a topic approved by guide and authorities.</p> <p>It is appreciated if student has already selected the domain of his/her dissertation work and identified the literature confined to the domain and thorough literature study based on identified topic has been carried out. This practice will eventually lead to convergence of the efforts for the dissertation work. The meticulous analyses of the literature can be part of seminar.</p> <p>The relevant literature then be explored as state-of-the-art, exotic, recent technological advancements, future trends, applications and research &amp; innovations. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.</p> <p>The students are expected to validate their study undertaken by publishing it at standard platforms.</p> <p>The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.</p> <p>The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in seminar logbook approved by Board of Studies.</p> |                            |  |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>610105 : Dissertation Stage I</b>  |                            |  |
|---|----------------------------|--|
| <b>Teaching Scheme:</b><br><b>Practical: 08 Hrs/week</b>  | <b>Credit</b><br><b>08</b> | <b>Examination Scheme:</b><br><b>TW: 50 Marks</b><br><b>Presentation: 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To identify the domain of research</li> <li>To learn to communicate in a scientific language through collaboration with guide.</li> <li>To understand the various means of technical publications and terminologies associated with publications</li> <li>To categorize the research material confined to the domain of choice</li> <li>To formulate research problem with the help of the guide/mentor elaborating the research.</li> <li>To Acquire information independently and assessing its relevance for answering the research questions.</li> </ul>   |                            |  |
| <b>Course Outcomes:</b><br>On completion of the course the student should be able to- <ul style="list-style-type: none"> <li>Conduct thorough literature survey confined to the domain of choice</li> <li>Develop presentation skills to deliver the technical contents</li> <li>Furnish the report of the technical research domain</li> <li>Analyze the findings and work of various authors confined to the chosen domain</li> </ul>   |                            |  |
| <p>Dissertation Stage – I is an integral part of the Dissertation work. In this, the student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart,) and Layout &amp; Design of the Set-up.</p> <p>The student is expected to complete the dissertation at least up to the design phase. As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly approved and certified progress report of Dissertation Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.</p> <p>The examiner will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report.</p> <p>The students are expected to validate their study undertaken by publishing it at standard platforms.</p> <p>The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.</p> <p>The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.</p> <p>The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines circulated / as in dissertation workbook approved by Board of Studies. Follow guidelines and formats as mentioned in Dissertation Workbook.</p> |                            |  |

# Semester IV

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>610107 : Seminar III</b>   |                            |   |
|---|----------------------------|---|
| <b>Teaching Scheme:</b><br><b>Practical: 20 Hrs/week</b>  | <b>Credit</b><br><b>20</b> | <b>Examination Scheme:</b><br><b>TW: 150 Marks</b><br><b>Presentation: 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.</li> <li>To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms, services.</li> </ul>  |                            |   |
| <b>Course Outcomes:</b><br>On completion of the course, student will be able– <ul style="list-style-type: none"> <li>To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression,.</li> <li>To acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication.</li> <li>To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across</li> </ul>   |                            |   |
| <p>The student shall have to deliver the seminar III in semester IV on a topic approved by guide and authorities. Preferably the seminar III may be extension of seminar II. The relevant literature then be explored as state-of-the-art, exotic, recent technological advancement, future trend, application and research &amp; innovation. The student shall submit the duly certified seminar report in standard format, for satisfactory completion by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.</p> <p>The students are expected to validate their study undertaken by publishing it at standard platforms.</p> <p>The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.</p> <p>The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, the department will follow the seminar guidelines circulated / as in logbook approved by Board of Studies.</p> |                            |   |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>610108 : Dissertation Stage II</b>  |                            |   |
|--|----------------------------|---|
| <b>Teaching Scheme:</b><br><b>Practical: 20 Hrs/week</b>   | <b>Credit</b><br><b>20</b> | <b>Examination Scheme:</b><br><b>TW: 150 Marks</b><br><b>Presentation: 50 Marks</b> |
| <b>Course Objectives:</b> <ul style="list-style-type: none"> <li>To follow SDLC meticulously and meet the objectives of proposed work</li> <li>To test rigorously before deployment of system</li> <li>To validate the work undertaken</li> <li>To consolidate the work as furnished report</li> </ul>   |                            |   |
| <b>Course Outcomes:</b><br>On completion of the course the student shall be able to- <ul style="list-style-type: none"> <li>Show evidence of independent investigation</li> <li>Critically analyze the results and their interpretation ; infer findings</li> <li>Report and present the original results in an orderly way and placing the open questions in the right perspective.</li> <li>Link techniques and results from literature as well as actual research and future research lines with the research.</li> <li>Appreciate practical implications and constraints of the specialist subject</li> </ul>  |                            |   |
| <b>Guidelines:</b><br>In Dissertation Work Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of Selection of Technology, Installations, UML implementations, testing, Results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions. The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.<br><br>The students are expected to validate their study undertaken by publishing it at standard platforms.<br><br>The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.<br><br>The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.<br><br>The continuous assessment of the progress need to be documented unambiguously.<br><u><b>It is recommended to continue with guidelines and formats as mentioned in Dissertation Workbook approved by Board of Studies.</b></u> |                            |   |

# Non Credit Courses



| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>NCC1: Game Engineering</b>  |  |
|--|--|
| <b>Course Contents</b>   |  |
| <b>1. Introduction to Unity 3D Game Engines</b> <ul style="list-style-type: none"> <li>Introduction to game industry ,Unity Basic (Interface Intro), Intro to tools &amp; navigation, The Main Windows, Game Objects , Scenes ,Cameras and Types, The assets store, Intro to Asset Work flow</li> </ul> <b>2. Basic Photoshop</b> <ul style="list-style-type: none"> <li>File types, size and resolution, Cropping and Editing sprite sheet</li> </ul> <b>3. C# programming in unity</b> <b>4. 2D Game Development Using Unity 3D</b> <ul style="list-style-type: none"> <li>Intro to 2D Game system in unity, Sprite Editor in Unity, Sprite Animation in Unity</li> <li>2D Physics in Unity</li> </ul> <b>5. 3D Game Development Using Unity 3D</b> <ul style="list-style-type: none"> <li>UI system in Unity, Artificial Intelligence for 3D Game</li> <li>Object Oriented Design &amp; Programming for 3D Games</li> <li>Multiplayer Game in unity, Creating 3D Game For PC</li> </ul> |  |
| <b>Books</b>   |  |
| <b>1.</b> Fabian Birzele, <u>“The Java Game Development Tutorial</u><br><b>2.</b> Sean M. Tracey, <u>“Make Games with Python on Raspberry Pi”</u>  |  |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>NCC2: Advanced Cognitive Computing</b>  |  |
|--|--|
| <b>Course Contents</b>   |  |
| <b>1. The Foundation of Cognitive Computing</b><br>Interdisciplinary Nature of Cognitive Science, Cognitive Computing Systems, Representations for Information and Knowledge, Principal Technology Enablers of Cognitive Computing, Cognitive Computing Architectures and Approaches, Cognitive Computing Resources<br><b>2. Cognitive Computing and Neural Networks: Reverse Engineering the Brain</b><br>Brain Scalability, Neocortical Brain Organization, The Concept of a Basic Circuit, Abstractions of Cortical Basic Circuits, Large-Scale Cortical Simulations, Hardware Support for Brain Simulation, Deep Learning Networks<br><b>3. The Relationship Between Big Data Analytics and Cognitive Computing</b><br>Evolution of Analytics and Core Themes, Types of Learning, Machine Learning Algorithms, Cognitive Analytics: A Coveted Goal, Cognitive Analytics Applications<br><b>4. Applications of Cognitive Computing</b><br>Applications in expert systems, Natural language programming, neural networks, robotics, virtual reality, Future applications |  |
| <b>Books</b>   |  |
| <b>1.</b> ‘Cognitive Computing and Big Data Analytics’, by Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Wiley publications, ISBN: 978-1-118-89662-4<br><b>2.</b> ‘Cognitive Computing: Theory and Applications’, by Vijay Raghvan, Venu Govindaraju, C.R. Rao, Elsevier publications, eBook ISBN: 9780444637512, Hardcover ISBN: 9780444637444<br><b>3.</b> <a href="https://www.research.ibm.com/software/IBMResearch/multimedia/Computing_Cognition_WhitePaper.pdf">https://www.research.ibm.com/software/IBMResearch/multimedia/Computing_Cognition_WhitePaper.pdf</a>  |  |

|  |  |
|--|--|
| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>NCC3: Reconfigurable Systems</b>  |  |
| <b>Course Contents</b>   |  |
| <p><b>1. Introduction to reconfigurable systems:-</b> Reconfigurable system (RS), Reconfigurable computing (RC), Architectural components of a configurable computer, primary methods in conventional computing: Application Specific Integrated Circuit (ASIC), software-programmed microprocessors,</p> <p><b>2. Reconfigurable computing:-</b>Theories:-Tredennick's Classification, Hartenstein's Xputer, High-performance computing, Partial re-configuration, Current systems Computer emulation, COPACOBANA, Mitronics, National Instruments, Xilinx, Intel,</p> <p><b>3. Advanced Applications and Technologies:-</b> Reconfigurability mechanisms, Reconfigurable devices and fabrics, Programmable pathways, Reconfigurability enablers,</p> <p><b>4. The Future of Reconfigurable Systems:-</b> Introduction, Multi-million gate FPGA Architectures, future Field Programmable System-on-a-Chip (FPSC), FPGA Architectures for Reconfigurable Computing, CAD Support for Reconfigurable Systems, Applications</p> |  |
| <b>Books</b>   |  |
| <ol style="list-style-type: none"> <li>1. Gokhale, Maya, B., Graham, Paul S., “ Reconfigurable Computing Accelerating Computation with Field-Programmable Gate Arrays”, 2005, 238 p., Springer Netherland, Hardcover ISBN: 0-387-26105-2</li> <li>2. Bobda Ch, “ Introduction to Reconfigurable Computing Architectures, Algorithms, and Applications”, Springer Netherlands, 2007, ISBN 978-1-4020-6088-5, 5 (Print) 978-1-4020-6100-4 359 3. Papers on the web page of the course Reconfigurable Circuits</li> <li>3. Katherine Compton and Ccott Hauck, “ Reconfigurable Computing: A Survey of Systems and Software”, ACM Computing Surveys, Vol. 34, No. 2, June 2002, pp. 171–210.</li> </ol>  |  |

|   |  |
|---|--|
| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>NCC4: Convergence Technology</b>   |  |
| <b>Course Contents</b>  |  |
| <p><b>1. Introduction-Convergence</b> continues to gain momentum Worldwide, Responding to convergence, Thinking Strategies about ICT Convergences</p> <p><b>2. Security Convergence</b> Types of convergence, Security convergence collaboration, Categories of Convergence Convergence Trends: Value of technology, Convergence in design</p> <p><b>3. Security Planning</b> Convergence Initiatives, Convergence and Layers of Security, Levels of Security Need of Technology roadmap</p> <p><b>4. Convergence in Practice</b> The Nimble Giants: How converged business models drive successful large enterprises The New face of public sector Small Enterprises Benefits from Strategic Investment management</p> |  |
| <b>Books</b>  |  |

1. Rajendra Singh and Siddhartha Raja, "Convergence in Information and Communication Technology", World Bank, ISBN, 0821381695, 9780821381694
2. Faisal Hoque, "The power of Convergence", AMACOM, ISBN-10: 0814416950,
3. Richard Baldwin, "The Great Convergence", Harvard University Press, ISBN-13: 978-0674660489
4. Ray Bernard "Security Technology Convergence Insights", Ray Bernard., ISBN: 9780128030011.

**Savitribai Phule Pune University**  
**Master of Computer Engineering (2017 Course)**  
**NCC5: Machine Intelligence**

**Course Contents**

1. Introduction to Machine Intelligence, What is MI?, Background/history, Spin-offs, High-level overview, State of the art.
2. Representation of Knowledge- Knowledge Representation, Knowledge Representation using predicate logic, introduction to predicate calculus, resolution, Knowledge Representation using other logic-structured Knowledge Representation.
3. Planning and Machine Learning- Basic Plan generation systems-strips, Advanced Plan generation systems-K strips, Strategic explanations, Machine learning, Adaptive Learning
4. Expert Systems- Architecture of Expert Systems, Roles of Expert Systems, Knowledge acquisition-Meta knowledge heuristics.

**Books**

1. Stefan Edelkamp and Stefan Schroedl. Heuristic Search: Theory and Applications, Morgan Kaufmann, 2011.
2. John Haugeland, Artificial Intelligence: The Very Idea, A Bradford Book, The MIT Press, 1985.
3. Judea Pearl. Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley, 1984.

**Savitribai Phule Pune University**  
**Master of Computer Engineering (2017 Course)**  
**NCC6: Storage Area Networks**

**Course Contents**

1. **Introduction to Information Storage Technology, Storage System Environment and Data protection:** Evolution, Key Challenges in Managing Information, Information Lifecycle Components, Disk Drive Components & Performance,
2. **Different Storage Technologies and Virtualization**  
 Introduction to **Networked Storage**, Overview of FC-SAN, NAS, and IP-SAN. Network-Attached Storage (NAS) & its Components, File Sharing, I/O operations, Performance and Availability. Content Addressed Storage, Storage Virtualization
3. **Content-Addressed Storage, Business Continuity, Backup and Recovery, Local Replication, Remote Replication:**  
 BC Terminology, Failure Analysis, Business Impact Analysis, Solutions, Backup Granularity, Recovery Considerations, Backup Methods, Process & Topologies, Backup in NAS Environments, Local Replication Technologies,
4. **Securing & Managing the Storage Infrastructure:**  
 Storage Security Framework, Risk Triad, Storage Security Domains, Security Implementations in Storage Networking Monitoring the Storage Infrastructure, Storage Management Activities, Storage Infrastructure Management Challenges,

**Books**

1. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill, Osborne, 2003.
2. Marc Farley, "Building Storage Networks", Tata McGraw Hill, Osborne, 2001.
3. EMC Educational Services, "Information Storage and Management", Wiley India
4. Meet Gupta, "Storage Area Network Fundamentals", Pearson Education Limited

**Savitribai Phule Pune University**  
**Master of Computer Engineering (2017 Course)**  
**NCC7: Search Engine Optimization**

**Course Contents****1. Basics for SEO, SEO Research & Analysis**

Basic Knowledge of Domain & World Wide Web, Difference between Portal and Search Engines, need of SEO, Types of SEO Techniques: Black hat techniques & White Hat techniques, Search Engine working Process, Keyword Research and Analysis, Keyword opportunity, Competitors Website Analysis, SWOT, On-page Optimization & Off-page Optimization

**2. On-page Optimization:** Meta Descriptions & Meta Keywords, Headings, Bold Text, Domain Names & Suggestions, Canonical Tag, Meta Tags, Images and Alt Text, Internal Link Building, Server and Hosting Check, Robots Meta Tag, 301 Redirects, 404 Error, Duplicate content**3. Off-page Optimization:** Page Rank, Link Popularity, Link Building in Detail, Directory Submission, Blog Submission, Links Exchange, Reciprocal Linking, Posting to Forums, RSS Feeds Submissions, Competitor Link Analysis**4. Analytics & SEO Tools**

Study of Google Analytics, How Google Analytics can Help SEO, Webmaster Central & Bing/Yahoo; Website Analysis using various SEO Tools available : Keyword Density Analyzer Tools, Google Tools, Yahoo / Bing Tools, Rich Snippet Text Tools, Comparison Tools, Link Popularity Tools, search Engines Tools, Site Tools

**5. SEO Reporting**

Google analysis, Tracking and Reporting, Reports Submission, Securing Ranks

**Books**

1. Jason McDonald Ph.D, "SEO Fitness Workbook: The Seven Steps to Search Engine Optimization Success"
2. Caimin Jones, "SEO Step-by-Step: The Complete Beginner's Guide to Getting Traffic"
3. Bruce Clay, " *Search Engine Optimization All-in-One for Dummies*
4. Adam Clarke, " SEO 2017: Learn search engine optimization with smart internet marketing strategies"

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>NCC8: Virtual Reality</b>  |  |
|---|--|
| <b>Course Contents</b>  |  |
| <b>1. Introduction and Background</b><br>What VR is and why it is so different from other mediums. Its history and different forms of reality, ranging from the real world to fully immersive VR. Its various hardware and components, which composes those realities.  |  |
| <b>2. Perception</b><br>Understanding the human brain and how we perceive real and virtual worlds, real-world examples that prove reality is not always what we think it is, explanations of perceptual models and processes, the physiology of the different sensory modalities, theories of how we perceive space and time, and a discussion of how perception relates to action. |  |
| <b>3. Designing in VR</b><br>Fundamentals of VR design including ergonomics, user testing, interface design, scale and scene setting, graphical user interfaces, and motion mechanics for mobile VR, simulator sickness, its causes.  |  |
| <b>4. VR Platforms and Applications</b><br>Understand what is happening in the VR industry, surveying current trends and technology in VR, the hardware: Mobile Performance & 360 Media, High-Immersion Unity, or High-Immersion Unreal.  |  |
| <b>Books</b>  |  |
| <b>1.</b> Jason Jerald, The VR Book: Human-Centered Design for Virtual Reality, Association for Computing Machinery and Morgan & Claypool New York, NY, USA©2016, ISBN: 978-1-97000-112-9   |  |
| <b>2.</b> John Vince, Virtual Reality Systems, Pearson Prentice Hall, ISBN 10: 0201876876 or ISBN 13: 9780201876871   |  |
| <b>3.</b> Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, 2nd Edition, ISBN: 978-0-471-36089-6   |  |

| <b>Savitribai Phule Pune University</b><br><b>Master of Computer Engineering (2017 Course)</b><br><b>NCC9: Machine Translation</b>  |  |
|---|--|
| <b>Course Contents</b>  |  |
| <b>1. Introduction:</b><br>Concept and translation process. Approaches viz rule based, statistical, Example based, hybrid and neural MT.  |  |
| <b>2. Learning and inference for translation models:</b><br>Maximum likelihood, Expectation maximization, Discriminative learning, Stochastic methods, Dynamic programming, Approximate search. |  |
| <b>3. Linguistic phenomena and their associated modeling problems:</b><br>Morphology, syntax and semantics.   |  |
| <b>4. Applications &amp; Evaluation:</b><br>Scaling, approximation and efficient data structures  |  |
| <b>Books</b>  |  |
| <b>1.</b> P. Koehn, “Statistical Machine Translation”, Cambridge University Press   |  |
| <b>2.</b> Pushpak Bhattacharyya, “Machine Translation”, 2015  |  |
| <b>3.</b> John Hutchinses, “Milestone in Machine Translation”   |  |

**Savitribai Phule Pune University**  
**Master of Computer Engineering (2017 Course)**  
**NCC10: Infrastructure Management**

**Course Contents**

**1. Introduction to Infrastructure Management**

What is Infrastructure Management, Basic Framework, Policy Issues, Types of Infrastructure Management: Systems Management, Network Management, Storage Management, Objectives, Benefits of Infrastructure Management system

**2. IT Infrastructure Management**

Components of IT Infrastructure, Hardware resources, Data storage, Input-output Technologies used in Businesses, Types of Computer Softwares used for Infrastructure Management in Business, Principle Issues, Foundations of Business Intelligence: Databases and Information Management, Telecommunications, Wireless Technology, Security

**3. Key System Applications for the Digital Age**

Achieving Operational Excellence and Customer Intimacy: Enterprise Applications, E-Commerce: Digital Markets, Digital Goods, Improving Decision Making and Managing Knowledge

**4. Building and Managing Systems**

Building Information Systems, Ethical and Social Issues in Information Systems

**Books**

1. Jane P. Laudon, Azimuth, “Essentials of Business Information Systems”, Pearson, ISBN-10: 0132277816, ISBN-13: 9780132277815
2. Barbara Klein, Richard Alan Long, Kenneth Ray Blackman, “Introduction to IMS, An: Your Complete Guide to IBM Information Management System”, IBM Press, ISBN-10: 0132886871, ISBN-13: 9780132886871
3. David Boddy, Albert Boonstra, “Managing Information Systems: Strategy and Organization”, Financial Times Press, ISBN-10: 0273716816, ISBN-13: 9780273716815