DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 1 - PROPERTIES OF FLUID

SUBJECT: FLUID MECHANICS **COURSE : SE (2015 Pattern)**

THEORY QUESTIONS

Q.1	What is fluid ? What is continuum ? What are different types of fluid ? Explain.	6
Q.2	Define viscosity or dynamic viscosity. Define and explain Newton's law of viscosity.	6
Q.3	What is surface tension ? Explain.Derive equation of intensity of pressure for Droplet.	6
Q.4	Derive equation of intensity of pressure for soap bubble and for liquid jet.	6
Q.5	State and explain Pascal's law. Derive equation of intensity of pressure	6
Q.6	Explain compressibility. Define Bulk modulus. Derive an expression for height of capillary	6
Q.7	Explain Vapour Pressure.	6
Q.8	Prove that the centre of pressure of a plane surface is always below the centre of gravity when immersed in liquid.	6
Q.9	Derive an expression for total pressure and centre of pressure for an inclined plane surface, immersed in static mass of a liquid.	6
Q.10	Explain briefly different types of equilibrium of floating bodies.	6
Q.11	Explain with neat sketches, the condition of equilibrium of floating and submerged bodies.	6
Q.12	Explain how horizontal and vertical components of the result pressure on a submerged curved surface are determined	6
Q.13	State and explain the Archimede's principle. Define principle of flotation.	6
Q.14	Define Buoyancy. Define centre of Buoyancy.	6
Q.15	Explain the term Metacentre. Define metacentric height. Derive an expression for determinatin of meacentric height of floating bodies by analytical method.	6

NUMERICALS

Q.16	A cube of 0.2 m sides and mass of 30 kg slides down a plane inclined at 30° to the horizontal and covered by a thin film of viscosity 2.3 x 10-3 Ns/m2. If the thickness of the film is 0.02 mm, determine the speed of the block.	6
Q.17	A body with gravity force of 500 N with a flat surface area 0.2 m² slides down a lubricated inclined plane making a 30° angle with the horizontal. For viscosity of 0.1 kg.m/s and body speed of 1 m/s. Determine the lubricant film thickness.	6
Q.18	A 90 N rectangular solid block slides down a 30° inclined plane. The plane is lubricated by a 3 mm thick film of oil of relative density 0.9 and viscosity 8.0 poise. If the contact area is 0.3 m2, estimate the terminal velocity of the block.	6
Q.19	A piston 100 mm diameter 125 mm in length moves in a vertical cylinder of 100.4 mm diameter. The annular space between the piston and the cylinder is filled with lubricating oil of viscosity 0.08 Pa-s. If the weight of the piston is 30N, at what velocity the piston would slide ?	6
Q.20	The space between two square flat parallel plates is filled with oil. Each side of the plate is 720 mm. The thickness of the oil film is 15 mm. The upper plate, which moves at 3 m/s requires a force of 120 N to maintain the speed. Determine : (i) The dynamic viscosity of the oil. (ii) The kinematic viscosity of oil if the specific gravity of oil is 0.95	6

Q.21 The velocity distribution in the flow of a thin film of oil down an inclined channel is given by : $u = \frac{v}{2\mu}(d^2 - y^2).\sin\alpha$
Where d - depth of flow, α - angle of inclination of the channel with horizontal, u- velocity at a depth y below the free surface, v - unit weight of oil and μ - dynamic viscosity of oil. Calculate the shear stress : (i) On the bottom of the channel (ii) At mid depth and (iii) At the free surface — 6

Q.22 If the bulk modulus of elasticity of water is 2.07 x 10^6 kN/m^2 : (i) What is the pressure required to reduce its volume by 2% ? (ii) What will be the change in mass density ? — 6

Q.23 A glass tube of internal diameter 2 mm is partially dipped in glycerine with its lower end 30 mm deep below surface. Air is blown in the tube so as to form an air bubble at its bottom end of the tube. If specific weight and surface tension of glycerine are 12.356 kN/m^2 and 0.0637 N/m, find the pressure of air blown. — 6

Q.24 A shaft of 150 mm diameter moves in a sleeve of length 300 mm at a speed of 0.5 m/s under the applications of 200 N force in the directions of its motions. If the clearance between the shaft and sleeves is 0.08 mm, Calculate the viscosity of the lubricating oil in the gap if the applied force is increased to 1000 N, what will be the speed of the sleeve ? — 6

Q.25 Determine the torque and power required to turn a 10 cm long, 5 cm diameter shaft. at 500 rpm in a 5.1cm diameter concentric bearing flooded with a lubricating oil of viscosity 100 centipoises. — 6

Q.26 **A** circular disc of radius r is kept at a small height above a fixed bed by means of a layer of oil of viscosity 'μ', obtain an expression for the viscous torque on the disc. — 6

Q.27 A 0.12 m disc rotates on a table separated by an oil film of 0.018m thickness. Find the viscosity of oil if the torque required to rotate the disc at 60 r.p.m. is 4 x 10- 4 Nm. Assume the velocity gradient in the oil film to be linear. — 6

Q.28 The gap between a rotating circular disc and a parallel plane fixed surface is 1 mm. The gap is filled with a fluid of viscosity 1 N-s/m^2. The diameter of the disc is 10 cm. Find the torque that should be exerted on the rotating disc so that it rotates at a constant speed of 70 rpm. — 6

Q.29 Barometric reading at a place is 75 cm of Hg. Express the pressure intensity of 10 N per cm2 is : (i) m of water (ii) mm of mercury (iii) KN/m^2 abs. — 6

Q.30 Mass density of a liquid varies as p = (1000 + 0.008 h), where 'h' is depth (m) below free surface of liquid. Determine depth at which gague pressure would be 100 kPa. — 6

Q.31 The diameters of a small piston and a large piston of a hydraulic jack are 3 cm and 10 cm respectively. A force of 80 N is applied on the small piston. Find the load lifted by the large piston when :
(i) The pistons are at the same level.
(ii) Small piston is 40 cm above the large piston.
Assume the liquid in the jack as a water. — 6

Q.32 A square plate of diagonal 1.5 m is immersed in water with its diagonal vertical and upper corner 0.5 m below the free surface of water. Calculate the depth of centre of pressure on the plate from the free surface of water and the hydrostatic force resulting on the plate in kN. — 6

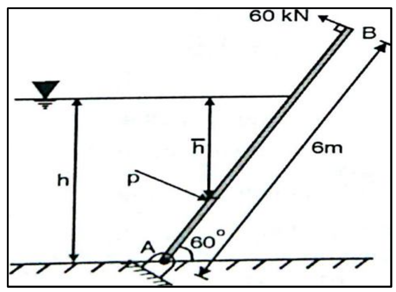
Q.33 A square plate of diagonal 2 m is immersed in water with its diagonal vertical and upper corner 0.5 m below the free surface of water. Find the hydrostatic force on the plate and the depth of centre of pressure from the free surface of water. — 6

Q.34 A square plate 6 m x 6 m is placed in a liquid of specific gravity 0.8 at an angle of 30° with free liquid surface. A square hole 1.5 m in size is cut exactly in the center of the plate. Its greatest and the least depths below the free liquid surface are 4 m and 2 in respectively. Determine the total pressure on one face of the plate and position of center of pressure. 6

Q.35 A circular plate 1.2 m diameter is placed vertically in water such that the centre of the plate is 2.5 m below the free surface. Determine the total pressure on the plate and depth of centre of pressure. 6

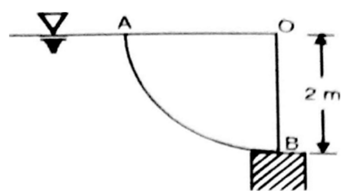
Q.36 A rectangular plane surface 3 m wide and 4 m deep lies in water in such a way that its plane makes an angle of 45° with the free surface of water. Determine the total pressure and position of center of pressure when the upper edge is 3 m below the free surface. 6

Q.37 A 6 m x 2 m rectangular gate is hinged at the base and is inclined at an angle of 60° with the horizontal. The upper end of the gate is kept in position by weight of 60 kN, acting at an angle of 90° as shown in Fig. 1. Neglecting weight of the gate, find level of water when the gate begins to fall. 6

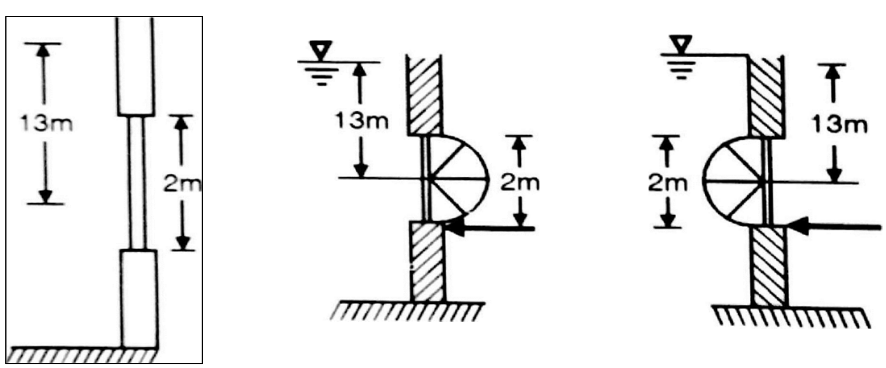


Q.38 A 3.6 m by 1.5 m wide rectangular gate is vertical and is hinged at point 0.15 m below the centre of gravity of the gate. The total depth of water is 10 m. What horizontal force must be applied at the bottom of the gate to keep the gate closed? 6

Q.39 Determine and locate the components of t 1w force due to water acting on the curved surface Ali as shown in Fig. 2 ; per meter of its length. 6



Q.40 An opening 1 m wide 2m high in the wall of a Dam is closed by a gate of the same size hinged at centre water level in the to is 13 m above the hinge and gate is held in position by a force F applied at its bottom edge. Find 'F'.
If the flat gate replaced by a semi-cylindrical one, as shown in Fig. 3 (b) and (c). Find the change in force F to be applied at the bottom edge, to keep the gate in position. 6



DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 2 - Kinematics of Fluid Motion

SUBJECT: FLUID MECHANICS **COURSE : SE (2015 Pattern)**

THEORY QUESTIONS

Q.1	Define local acceleration. Define convective acceleration.	6
Q.2	Explain streak line, path line and stream line.	6
Q.3	Explain the concept of 'stream tube' with sketch.	6
Q.4	Discuss various types of flows with example. Differentiate between the convective and local acceleration.	6
Q.5	Short note on circulation and vorticity.	6
Q.6	Write short note on stream function and velocity potential function.	6
Q.7	Prove that equi-potential and streamline are perpendicular to each other. What is the significance of this perpendicularity ?	6

NUMERICALS

Q.8	Velocity field in fluid medium is given by : $\vec{V} = 10x^2yi + 15xyj + (25t - 3xy)k$ Find acceleration at (1, 2, -1) in and t = 0.5 sec.	6
Q.9	The velocity vector in a fluid flow is given $V = (2x^3)\hat{\imath} - (5x^2y)\hat{\jmath} + (2tz)\bar{k}$ Obtain expression for velocity vector and acceleration vector at a point (2, 1, 3) at time t = ls. Also calculate the value of velocity and acceleration at the given point.	6
Q.10	For the flow of an incompressible fluid, the velocity in x-direction u = ax2 + by and velocity in z-direction is zero. Find velocity component in y-direction such that v = 0 at y = 0.	6
Q.11	In a two-dimensional flow the velocity components are u = 6y and v = - 6x : (i) Is flow possible ? (ii) If so, determine the stream function.	6
Q.12	The velocity potential function (Φ) is given by : $\emptyset = \frac{xy^3}{3} - x^2 + \frac{x^3y}{3} + y^2$ Calculate the velocity components in x and y direction. (i) Check possibility of fluid flow. (ii)	6
Q.13	Calculate the velocity at the point (3, 3) for the following stream function $\varphi = \frac{1}{2}(y^2 - x^2) + xy - 6$	6
Q.14	A flow is described by a stream function $\varphi = 2\sqrt{3}\,xy$. Locate the point at which the velocity vector has a magnitude 4 units and makes an angle of 150° with X- axis.	6
Q.15	The velocity component in two-dimensional flow field are as follows : $u = \frac{y^3}{3} + 2x - x^2y, \quad v = xy^2 - 2y - \frac{x^3}{3}$ (i) Whether flow is possible (ii) Obtain an expression for a stream function for ψ. (iii) Obtain an expression for potential function forΦ.	6

Q.16 If the expression for stream function is described by $\psi = x^3 — 3xy^2$, determine whether flow is rotational or irrotational. If flow is irrotational, then indicates the correct value of velocity potential : 6

$$a)\ \emptyset = y^3 - 3x^2y \quad b)\ \emptyset = -3x^2y$$

Q.17 A stream function is given by $\psi = 3xy$. Determine : i) Whether the flow is possible. ii) Whether the flow is rotational or irrotational. iii) The potential function and (iv) Acceleration component at (1,1). 6

Q.18 The velocity components are given by $u = 4y$ and $v = — 4x$. Check whether the stream function is exists? If so, determine stream function and sketch a set of it. 6

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 3 -FLUID DYNAMICS

SUBJECT: FLUID MECHANICS **COURSE : SE (2015 Pattern)**

THEORY QUESTIONS

Q.1	List the various forces acting on fluid mass. Explain the significance of each term.	6
Q.2	Derive an expression of conservation of momentum in differential form.	6
Q.3	Derive an expression for continuity equation for 3D flow.	6
Q.4	Derive Euler's equations of motions along a streamline and further derive Bernoullis equation from that.	6
Q.5	State assumptions made in Bernoulli's equation.What are limitations of the Bernoulli's equation	6
Q.6	Derive an expression for Bernoullis equation along a streamline.	6
Q.7	Explain HGL. Explain TEL.	6
Q.8	Describe an venturimeter.	6
Q.9	Find an expression for measuring discharge of fluid through a pipe with venturimeter.	6
Q.10	Describe an orifice meter and find an expression for measuring discharge of fluid through a pipe with this device.	6
Q.11	Compare venturimeter and orifice meter.	6
Q.12	What is a pitot tube?How is it used to measure velocity of flow at any point in a pipe or channel	6
Q.13	What is a notch? State classification Of notches .	6

NUMERICALS

Q.14	In a vertical pipe conveying oil of specific gravity 0.8, two pressure gauges has been installed at A and B, where diameters are 16 cm and 8 cm respectively. A is 2 m above B. The pressure gauge readings have shown that pressure at B is greater than at A by 0.981 N/cm2. Neglecting all losses calculate flow rate.	6
Q.15	At a section in a horizontal pipe the diameter is 6 cm and the pressure is 80 kN/m2. At another section, the diameter is 10 cm and pressure is 120 kN/m2. if the discharge is 0.09 m3/s, determine the direction of flow.	6
Q.16	A pipeline 0.225 m in diameter and 1580 m long has a slope of 1 in 200 for the first 790 m and 1 in 100 for the next 790 m. The pressure at the upper end of the pipeline is 107.91 kPa and at the lower end is 53.955 kPa. Assume friction factor f = 0.04. Determine the discharge through the pipe.	6
Q.17	A pump is pumping water at the rate of 7536 lt/min. The pump inlet is 40 cm in diameter and the vacuum pressure over there is 15 cm of Mercury. The pump outlet is 20 cm in diameter and it is 1.2 m above the inlet. The pressure at the outlet is 107.4 kN/m2. Estimate the power added by the pump.	6
Q.18	A 200 mm **X** 100 mm venturimeter is provided in a vertical pipe carrying water flowing in a upward direction. A differential mercury manometer connected to the inlet and throat gives a reading of 220 mm. Find the rate of flow.	6
Q.19	Determine the flow rate of oil with specific gravity 0.7 flows through pipe of diameter 400 mm inclined at 30° with horizontal connected with mercury differential Venturimeter of throat 200 mm gives the deflection of 500 mm. Take throat to mouth distance of 600 mm and flow meter coefficient as 0.98.	6

Q.20	Water flows through an inclined venturimerter. The inlet and throat diameters are 10 cm and 5 cm respectively and their height difference (Z2 - Z1) is 20 cm. A mercury manometer located across the inlet and throat indicates 12 cm mercury column at a given now rate. Estimate the flow rate, coefficient of discharge and pressure difference between inlet and the throat (P1 — P2) : (i) neglecting friction tii) when friction loss is 10% of the head indicated by the manometer.	6
Q.21	A 300 mm **X** 150 mm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow being upward. The difference in elevation of the throat section and entrance section of the venturimeter is 300 mm. The differential U-rube mercury manometer shows a gauge deflection of 250 mm. Calculate : (i) The discharge of oil, and (ii) The pressure difference between the entrance section and of the throat section. Take Cd = 0.98 and specific gravity of mercury as 13.6	6
Q.22	A venturimeter has its axis vertical, the inlet and throat diameters being 150 mm and 75 mm respectively. The throat is 225 mm above inlet and co-efficient of discharge is 0.96. Petrol of specific gravity 0.78 flows up through the meter at a rate of 0.029m3/s. Find the pressure difference between the inlet and the throat. Derive the formula that you used.	6
Q.23	The inlet and throat diameters of a vertically mounted venturimeter are 30 cm and 10 cm respectively. The throat section is below the inlet section at a discharge of 10 cm. The specific gravity of the liquid is 900 kg/m3. The intensity of pressure at inlet is 140 kPa and the throat pressure is 80 kPa. Calculate the flow rate in Lps. Assume that 2% of the differential head is lost between inlet and throat. Take coefficient of discharge 0.97.	6
Q.24	A venturimeter, fitted in horizontal 150 mm diameter pipeline, measures the flow of water which is 50 1ps. The pressure head at inlet for the flow is 15 m above atmosphere. Between inlet and thrat there is an estimated friction loss of 10 % of the pressure head difference between these two points. If the separation occurs at 2.3 in of water absolute. Calculate the minimum diameter of the throat of the meter.	6
Q.25	An orifice is to be used to indicate the flow-rate of water in a 30 mm diameter pipeline. The orifice diameter is 15 mm. What pressure reading will be experienced on the flow velocity of 3.2 m/sec? What could be the flow rate for a pressure reading of twice this value? Assume orifice discharge coefficient = 0.604 for a flow velocity of 3.2 in/sec and 0.601 in the latter case.	6
Q.26	A sub-marine with its axis 15 m below water surface fitted with pitot tube moves horizontally in sea of specific gravity 1.026 is fitted with mercury U-tube differential manometer giving a deflection of 170 mm. Calculate the speed of sub-marine.	6
Q.27	A pitot static tube is used to measure velocity of an aeroplane. U-tube differential manometer gives deflection of 100 mm of water. If specific weight of air is 12 N/m3 and coefficient of pitot tube is 0.98. Determine speed of aeroplane. Neglect compressibility effects.	6
Q.28	A sub-marine fitted with a Pitot tube moves horizontally in sea with its axis is 12 m below the surface of water. The Pitot tube fixed in front of the sub-marine and along its axis connected to the two limbs of a U-tube of a U-tube containing mercury, the reading of which is found to be 200 mm. Find the speed of the sub-marine. Take the speific gravity of sea water = 1.025 times fresh water.	6
Q.29	A tank containing water is provided with a sharp edged circular orifice of 7.5 mm diameter. The height of water in tank is 1.44 m above the orifice wall 1.5 m away and 0.42 m vertically below the centre line of the contracted section of jet. The actual discharge through the orifice is measured to be 35 litres in 4 minutes. Determine : (i) The orifice co-efficients. (ii) The power loss at orifice.	6

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 4 - INTERNAL FLOWS

SUBJECT: FLUID MECHANICS **COURSE : SE (2015 Pattern)**

THEORY QUESTIONS

Q.1	Derive an expression for velocity profile for laminar flow through pipe.	6
Q.2	Prove that, in case of steady laminar flow through a circular pipe average velocity is half of the maximum velocity.	6
Q.3	Derive Higen-Poiseuille's equation for a steady uniform laminar flow through circular pipe.	6
Q.4	Derive an expression of velocity and shear stress distribution for laminar flow between fixed parallel plates.	6
Q.5	Derive an expression of shear stress distribution for laminar flow between fixed parallel plates.	6

NUMERICALS

Q.6	A laminar flow is taking place in a pipe of diameter 0.2m. The maximum velocity is 1.5m/s.Find the mean velocity and the radius at which this occurs. Also calculate the velocity at 0.04m from the wall of the pipe.	6
Q.7	A lubricating oil of viscosity of 10 poise and specific gravity 0.8 is pumped through a 50 mm diameter pipe. If the pressure drop per meter length of pipe is 20 kN/m2, determine : (1) Discharge of oil in litre/sec (2) Shear stress of pipe wall. (3) Total Frictional drag (4) Power required per 50 m, length of pipe to maintain flow.	6
Q.8	A pipe 60 mm diameter and 450 m long slopes upwards at 1 in 50. An oil of viscosity 0.9 Ns/m^2 and specific gravity 0.9 is required to be pumped at the rate of 5 1ps. (i) Is the flow laminar ? (ii) What is the power of the pump required assuming an overall efficiency of 65 %. (iii) What is the center line velocity and velocity gradient at pipe wall?	6
Q.9	A 0.2 m diameter pipe carries liquid in laminar regime. A pitot tube placed in the flow at a radial distance of 20 mm from the axis of the pipe indicates velocity of 0.5 m/s. Calculate : (i) The maximum velocity (ii) The mean velocity ; and (iii) The discharge in the pipe.	6
Q.10	Oil is pumped in a horizontal 150 mm diameter pipe 200 m long. The specific gravity of oil is 0.89 and kinematic viscosity is 1.3 stokes. The friction factor for the flow is given by 64/Re. It has 25 HP to drive the pump of efficiency 65%. Find the flow rate of oil.	6
Q.11	Two parallel plates kept 100 mm apart have laminar flow of oil between them maximum velocity of flow is 1.5 m/s, Calculate : (i) Discharge per metre width (ii) Shear stress at the plate (iii) The difference in pressure between two points 20 m apart (iv) Velocity gradient of plates (v) Velocity at 20 mm from the plate. Assume viscosity of oil 24.5 poise.	6
Q.12	Two parallel plates are kept 3 mm apart. For a steady laminar flow of oil between these plates, there was apressure drop of 10 kN/m2 per meter length of plates. If the viscosity of the oil is 5 X 10^(-2) N-s/m2, determine the discharge per meter width of plates, maximum shear and maximum velocity of flow.	6
Q.13	There is a horizontal crack 40 mm wide and 2.5 mm deep in a wall of thickness 100 mm. Water leaks through the crack. Find the rate of leakage of water through the crack if the difference of pressure between the two ends of crack is 0.02943 N/cm2. Take the viscosity of water equal to 0.01 poise.	6

Q.14 Oil of viscosity 0.05 Ns/m2 is flowing between two stationary parallel plates 1m wide and maintained 10 mm part. The velocity midway between the plates is 3 m/s. Find: (1) Pressure gradient along flow (ii) Average velocity (iii) Discharge of oil — 6

Q.15 For turbulent flow in circular pipe of radius `r' friction factor is 0.02. Estimate the local velocity at a radial distance 0.25 r from the axis of the pipe. If mean velocity is 0.3 m/s, what will be the velocity at the centre line of pipe ? — 6

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO.5 - FLOW THROUGH PIPES

SUBJECT: FLUID MECHANICS **COURSE : SE (2015 Pattern)**

THEORY QUESTIONS

Q.1	Explain major and minor losses in the pipe in detail.	6
Q.2	What are minor losses ? Under what circumstances will they be negligible ?	6
Q.3	Derive Darcy-Weisbach formula for calculating loss of head due to friction in pipe.	6
Q.4	Sketch Moody chart and explain how it is to be used.	6
Q.5	Derive an expression for the power transmission through the pipes.	6
Q.6	Derive an expression for maximum power transmitted through the pipe.	6
Q.7	Explain in brief the Buckingham it-theorem as method of dimensional analysis.	6
Q.8	What are repeating variables ? What points are important while selecting repeating variables ?.	6
Q.9	Explain in brief the physical significance of Froude's number. Explain Fronde model law.	6
Q.10	Explain Euler's number and Mach number.	6

NUMERICALS

Q.11	Water is to be supplied to the inhabitants of a college hostel through a supply main. The following data are given : Distance of the reservoir from the hostel = 4000 m. Number of inhabitants = 3000. consumption of water per day of each inhabitant = 180 its, loss of head due to friction = 18 m, coefficient of friction for the pipe f = 0.007. if the half of the daily supply is pumped in 8 hrs, determine the size of the supply main.	6
Q.12	A pipeline 0.225 m in diameter and 1580 m long has a slope of 1 in 200 for the first 790 m and 1 in 100 for the next 790 m. The pressure at the upper end of the pipeline is 107.91 kPa and at the lower end is 53.955 kPa. Determine the discharge through pipe. Take f = 0.032	6
Q.13	When a sudden contraction in introduced in a horizontal pipeline from 500 mm diameter to 250 mm diameter, the pressure changes from 105 kN/m2 to 69 kN/m2.If the co-efficient of contraction is assumed to be 0.65. Calculate the water flow rate. Instead of this if sudden expansion is introduce of same size and if the pressure at the 250 mm section is 69 kN/m3, What is the pressure at the 500 mm enlarge portion ?	6
Q.14	A 15 cm diameter vertical pipe is expanded to 25 cm diameter suddenly at a section. The head loss at a sudden expansion from section I to II, which are 50 cm apart is $h_c = (V_1 — V_2)^2 / 2g$. For a discharge of 45 litre/sec, calculate the reading 'x' of the mercury water differential manometer.	6
Q.15	A horizontal pipeline 40 metres long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 metres of its length the pipe is 15 cm diameter and then its diameter is suddenly enlarged to 30 cm. The height of water level in the tank is 8 mts above centre of pipe. Considering all losses of head which occur determine the rate of flow. Take *1*= 0.01 for both the sections of the pipe.	6
Q.16	At a sudden enlargement of water main from 0.24 m to 0.48 m diameter, hydraulic gradient rises by 10 mm. Estimate the rate of flow.	6

Q.17	Two reservoirs containing water have difference of levels of 70m and are connected by a 250 mm diameter pipe which is 4 km long. The pipe is tapped midway between reservoirs and water is drawn at rate of 0.04 m3/sec, Assuming friction factor = 0.04, determine rate at which water enters in the lower reservoir,	6
Q.18	The difference in water level, between two tanks which are connected by three pipes in series is 15 m. length and diameter of rate at which water enters in the lower reservoir, these pipes are 300 m, 150 m, 200 m and 30 cm, 20 cm and 30 cm respectively. Find the discharge through the pipeline and tabulate all losses if f for the three pipes to be taken as 0.02, 0.025 and 0.03.	6
Q.19	Three pipes are connected in series to make a compound pipe. Sizes of the pipes are as below. Pipe 1, 2 and 3 having diameters 200, 400 & 600 mm respectively and lengths 400, 800 & 1200 m respectively. The ends of this compound pipe are connected with two tanks whose difference of water levels is 20 In. if coefficient of friction for these pipes is same and equal to 0.006, determine the discharge through the compound pipe (i) Neglecting the minor losses and (ii) Including the minor losses.	6
Q.20	Two pipes of 20 cm and 30 cm diameter are laid in parallel to pass a total discharge of 100 l.p.s. Each pipe is 250 m long. Determine discharge through each pipe. Now these pipes are connected in series to connect two tanks 500 m apart to carry same total discharge. Determine water level difference between the tanks. Neglect minor losses in both cases. Take f = 0.02 for both pipes.	6
Q.21	Two sharp ended pipes of diameters of 50 mm and 100 mm respectively, each of length 100 m are connected in parallel between two reservoirs which have a difference of laver of 10 m. If the friction factor for each pipe is 0.32, calculate: (1) Rate of flow for each pipe and (2) The diameter of a single pipe 100 m long which would give the same discharge, if it were substituted for the original two pipes.	6
Q.22	A main pipe divides into two parallel pipes which again forms one pipe. The length of parallel pipes is 2000 m and diameters are 1.0 m and 0.8 m respectively. Find the flow in each parallel pipe if total flow in the main pipe is 3 m3/sec. Assume coefficient of friction for each pipe as 0.005.	6
Q.23	A pipeline of 600 mm diameter is 1.5 km long. To increase the discharge, another pipeline of same diameter is introduced parallel to the first in the second half of the length. If f = 0.04 and head at the inlet is 300 mm, calculate the increase in discharge. Neglect minor losses in pipelines and f is a Darcy friction factor.	6
Q.24	A straight 25 cm pipeline 5 km long is laid between two reservoirs having a difference in level of 40 m. To increase the capacity of the system an additional 2.5 km long 25 cm pipe is laid parallel from the first reservoir to the midpoint of the original pipe. Assuming friction factor as 0.025 for both the pipes; find the increase in discharge due to installation of the new pipe.	6
Q.25	A piping system consists of three pipes arranged in series; the lengths of the pipes are 1200 m, 750 m and 600 m and diameters 750 mm, 600 mm and 450 mm respectively. Transform the system to an equivalent 450 mm diameter pipe and determine an equivalent diameter for the pipe, 2550 m long.	6
Q.26	A pipeline, 300 mm in diameter and 3200 m long is used to pump up 50 kg per second of an oil whose density is 950 kg/m3 and whose kinematic viscosity is 2.1 stokes. The center of the pipeline at the upper end is 40 m above than that at the lower end. The discharge at the upper end is atmospheric. Find the pressure at the lower end draw H.G.L and T.E.L.	6

Q.27	Two reservoirs are connected by a pipeline consisting of two pipes, one of 15cm diameter and length 6 m, and other of diameter 22.5 cm and 16 m length. If difference of water levels in the two reservoirs is 6m, calculate the discharge and draw E.G.L. Take coefficient of friction (f) = 0.04.	6
Q.28	A 2500 m long pipeline is used for transmission of power. 120 kW power is to he transmitted through the pipe in which water having a pressure of 4000 kN/rn2 at inlet is flowing. If the pressure drop over the length of pipe is 800 k.N/m2 and f = 1.006. Find : (i) Diameter of the pipe (ii) Efficiency of transmission (iii) Also find the maximum efficiency.	6
Q.29	Two reservoirs having a difference in elevation of 15 m are connected by a 200 diameter syphon. The length of syphon 400 mm and the summit is 3 m above the water level in the upper reservoir. The length of pipe from upper reservoir to summit is 120 m. If the coefficient of friction is 0.02, determine (negicet minor losses). (1) Discharge through siphon (2) Pressure at the summit.	6
Q.30	A siphon of diameter 200 mm connects two reservoirs having a difference of elevation of 20 m. The total length of siphon is 800 m and the summit is 5 m above the water level in the upper reservoir. If separation takes place at 2.8 m of water absolute. Find max length of siphon from upper reservoir to summit. Take friction factor = 0.016, atmospheric pressure is 10.3 m of water.	6
Q.31	A siphon of diameter 200 mm connects two reservoirs having a difference in elevation of 15 mt. The total length of siphon is 600 m and summit is 4 m above the water level in the upper reservoir. If separation takes place at 2.8 m water absolute, find the maximum length of siphon from upper reservoir to summit take friction coefficient as 0.004 and atmospheric pressure as 10.3 m of water.	6
Q.32	The resisting force R of a supersonic plane during flight can be considered as a dependant upon the length of the aircraft *l*, velocity V, air viscosity μ, air density ρ, and bulk modulus of air K. Express the functional relationship between these variables and the resisting force.	6
Q.33	Assuming the viscous force F exerted by a fluid on sphere of diameter D depends on viscosity μ, mass density ρ and velocity of sphere v. Obtain expression for the viscous force.	6
Q.34	The velocity of flow u very near a rotating disk depends on the angular velocity ω of the disc, the radial distance r, vertical distance 'z' and kinematic viscosity of fluid υ. Derive a relation for u in a dimensionless form.	6
Q.35	The efficiency η of a fan depends on density ρ, dynamic viscosity μ, of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express the efficiency η in terms of dimensionless parameter.	6
Q.36	The performance of an oil ring consuming a discharge Q of oil depends on the internal diameter *d* of the ring, the rotational speed N of the shaft the density ρ, the viscosity μ., surface tension λ and specific weight of the oil ω, show that : $Q = ND^3 \varnothing \left(\frac{\mu}{\rho ND^2}, \frac{\omega}{\rho DN^2}, \frac{\lambda}{\rho D^3 N^3}\right)$	6
Q.37	Using Buckingham's π Theorem, show that the velocity through circular orifice is given by : $V = \sqrt{2gH}\, f\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$ Where, H = Head causing flow, D = Diameter of orifice μ = Coefficient of viscosity, p = Mass density, g = Acceleration due to gravity	6

Q.38	The pressure drop Δp in a pipe of diameter D and length l depends on the density ρ, viscosity μ of the fluid flowing, mean velocity V of flow and average height of protuberance t, show that the pressure drop can be expressed in the form : $$\Delta p = \rho V^2 f\left(\frac{L}{D}, \frac{\mu}{\rho V D}, \frac{t}{D}\right)$$	6
Q.39	Show that the thrust on a propeller is given by : $$F = \rho D^2 V^2 \emptyset \left[\frac{\omega D}{V}, \frac{\rho V D}{\mu}\right]$$ Where the terms carry usual meaning.	6
Q.40	Torque T of a propeller depends on density of liquid ρ, viscosity of liquid μ, speed N rpm, linear velocity V, diameter of propeller shaft D. Using Buckingham's It Theorem. Show that: $$T = \rho N^2 D^5 \emptyset \left(\frac{ND}{V}, \frac{\rho N D^2}{\mu}\right)$$	6
Q.41	Power P developed by a water turbine on rotational speed N operating head H, diameter D, breadth B of runner, density ρ, viscosity μ of fluid and gravitational acceleration g show that : $$P = \rho D^5 N^3 \emptyset \left(\frac{H}{D}, \frac{B}{D}, \frac{\rho D^2 N}{\mu}, \frac{ND}{\sqrt{gH}}\right)$$	6
Q.42	Show that the resistance R to the motion of sphere of diameter d moving with uniform velocity V through a fluid of density ρ and viscosity μ is given by : $$R = \rho V^2 D^2 \emptyset \left(\frac{\mu}{\rho V D}\right)$$	6
Q.43	An oil of specific gravity 0.92 and viscosity 0.03 poise is to be transported at the rate of 2500 liters/sec through a 1.2 m diameter pipe. Test were conducted on a 12 cm diameter pipe using water at 20°C. If the viscosity of water at 20°C is 0.01 poise, find : (i) velocity of flow in the model (ii) rate of flow in the model.	6
Q.44	A geometrically similar model of an air duct is to be built to 1/25 scale and tested with water which is 50 times more viscous and 800 times than air. When tested under dynamically similar conditions, the pressure drop is 2 bar in the model. Find corresponding pressure drop in the full scale prototype.	6
Q.45	A 1/10 model of an airplane is tested in a variable density wind tunnel. The prototype plane is to fly at 400 km/hr speed under atmospheric conditions. The pressure used in the wind tunnel is 10 times the atmospheric pressure. Calculate the velocity of air in the model. To what prototype value would a measured drag of 500 N in the model correspond ?	6

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO.6 - EXTERNAL FLOWS

SUBJECT: FLUID MECHANICS **COURSE : SE (2015 Pattern)**

THEORY QUESTIONS

Q.1	Explain the significance of the boundary layer concept in fluid mechanics.	6
Q.2	Discuss the boundary layer formation over a flat plate. Define nominal thickness.	6
Q.3	Define and derive an expression for boundary layer displacement thickness.	6
Q.4	Define and derive an expression for momentum thickness.	6
Q.5	Define energy thickness. Derive an expression for the energy thickness.	6
Q.6	Write a note on separation of boundary layer and methods of controlling it.	6
Q.7	What is drag ? Define lift force.	6
Q.8	Explain different types of drag on an immersed body.	6
Q.9	Draw profile of symmetrical and unsymmetrical aerofoil and define aerofoil.	6
Q.10	Define chord line, angle of attack and camber.	6
Q.11	Prove the coefficient of lift of an aerofoil body depend on angle of attack.	6

NUMERICALS

Q.12	Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = \frac{y}{\delta}$,where u is the velocity at a distance y from the plate and u = U at y = δ, where δ = boundary layer thickness. Also calculate the value of δ^*/θ.	6
Q.13	Find the displacement thickness, momentum thickness and energy thickness for the velocity distribution in the boundary layer given by, $$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$	6
Q.14	If the velocity distribution in the boundary layer flow over a plate is given by, Find the displacement thickness where u = velocity of the fluid at any distance y from the plate in a normal direction. U = free stream velocity and δ = Boundary layer thickness at any distarce x from the leading edge in the direction of flow. $$\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$	6
Q.15	If velocity distribution in laminar boundary layer over a flat plate is assumed to be given by second order polynomial u = a + by + cy^2, determine its form using the necessary boundary condition.	6
Q.16	The velocity distribution in the boundary layer is given by $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{1/7}$ Calculate : (i) Displacement thickness (ii) Momentum thickness (iii) Shape factor (iv) Energy thickness	6
Q.17	A plate 3 m x 3 m is held horizontally in water moving at 1.25 m/s parallel to its length. If the flow in the boundary layer is laminar at the leading edge of the plate, (i) Find the thickness of boundary layer at this section. (ii) Find the frictional drag on the plate considering both its side Assume negligible thickness of the plate. Take dynamic viscosity of water as 0.01 P and assume that laminar boundary layer exists upto Reynold's number = 5 x 10^5.	6

Q.18	Calculate the thickness of the boundary layer at the trailing edge of smooth plate of length 4 m and width 1.5 m, when the plate is moving with a velocity of 4 m/sec in stationary air. Also determine the total drag on one side of the plate assuming that : (i) The boundary layer is laminar over the entire length of the plate and (ii) The boundary layer is turbulent from the very beginning. Take kinematic viscosity and density of air as 1.5 x 10^(- 5) m2/sec and 1.226 kg /m3 respe.	6
Q.19	Velocity distribution in a boundary layer is given below. Find whether flow is attached or detached (separated). $\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$	6
Q.20	For the velocity profile, $\frac{u}{U} = 2\left(\frac{y}{\delta}\right)^2 + \left(\frac{y}{\delta}\right)^3 - 2\left(\frac{y}{\delta}\right)^4$ Check whether flow is attached or detached or on the verge of separation.	6
Q.21	For the velocity profile, Check whether the flow adheresto or detaches from or on the verge of separation from the surface. $\frac{u}{U} = -\frac{3}{2}\eta + \frac{1}{2}\eta^3 + \eta^4$	6
Q.22	A car of frontal area 1.4 m2 travels in still air with speed 72 kmph. If drag coefficient is 0.350, calculate the power required to drive the car at this speed. Density of air is 1.2 kg/m3.	6
Q.23	A truck having a projected area of 6.5 m2, traveling at 70 km/h, has a total resistance of 2000 N. Of this 20 percent is due to rolling friction and 10 percent due to surface friction. The rest is due to form drag. Find coefficients of form drag. Take ρ = 1.22 kg/m3 for air.	6
Q.24	A flat plate 1.5 m x 1.5 m moves at a speed of 50 kmph in stationary air of density 1.15 kg/m3. Coefficient of drag and lift are 0.15 and 0.75 respectively. Determine : (i) The lift force on plate (ii) The drag force on plate (iii) Resultant force on plate (iv) Direction of the resultant force (v) Power required to keep the plate in motion.	6
Q.25	Experiments were conducted in a wind tunnel with a speed of 50 km/hour on a flat plate of size 2m long and 1 m wide. The density of air is 1.15 kg/m3. The coefficients of lift and drag are 0.75 and 0.15 respectively. Determine : (i) the lift force (ii) the drag force (iii) the resultant force (iv) direction of resultant force and (v) power exerted by air on the plate.	6
Q.26	On a flat plate of 2 m (length) x 1 m (width), experiments were conducted in a wind tunnel with a wind speed of 50 km/hr. The plate is kept at such an angle that the coefficients of drag and lift are 0.18 and 0.9 respectively. Determine : (i) Drag force (ii) Lift force (iii) Resultant force (iv) Power exerted by the air stream. Take ρ = 1.15 kg/m3 for air.	6
Q.27	A square plate of side 2 m is moved in a stationary air of density 1.2 kg/m3 with a velocity of 50 km/hr. Coefficient of drag and lift are 0.2 and 0.8 respectively. Determine : (i) The lift force (ii) The drag force (iii) Resultant force and (iv) Power required to keep the plate in motion.	6
Q.28	Assuming the cross-sectional area of a car to be 2.7 m^2 with a drag coefficient of 0.6, estimate the energy requirement at a speed of 60 km/h. Assume the weight of car to be 30 kN and coefficient of friction 0.012. Assume density to be 1.208 kg/m^3.	6
Q.29	After polishing the hull of a boat, it was noticed that coefficient of drag has reduced by 20%. If the same driving power is used, what would be the percent increase in the speed?	6

Q.30	A sphere of 4 cm diameter and relative density 2.8 is attached to a string and is suspended from the roof of a wind tunnel. If the air stream of 30 m/s flow past the sphere, find the inclination of string to horizontal and the tension in the string. Assume mass density of air is 1.2 kg/m^3 kinematic viscosity of air is 1.5 x 10^{-5} m^2/s. $C_D = 0.5\ for\ 10^4 < R_e < 3 \times 10^5 \qquad C_D = 0.2\ for\ R_e \geq 3 \times 10^5$	6
Q.31	A metallic ball of diameter 0.002 m drops in a fluid of specific gravity 0.95 and viscosity 15 poise. Density of ball is 12000 kg/m3, find : (i) Drag force exerted on ball (ii) Pressure drag and friction drag (iii) Terminal velocity of the ball	6
Q.32	A kite has a plan form area of 0.25 m2 and is flying in a wind of velocity 25 km/h. The kite has a net weight of 1.2 N. When the string is inclined at an angle of 15° to the vertical, the tension in the string was found out to be 3.0 N. Evaluate the coefficient of lift and drag. Take density of air as 1.15 kg/m3.	6