Code No: R21021 **R10** SET - 1

II B. Tech I Semester, Regular Examinations, Nov – 2012
FLUID MECHANICS AND HYDRALICS MACHINES
(Com. to EEE, ME, MM)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Define Viscosity. Derive Newton's equation of viscosity. Explain the variation of shear stress with velocity gradient in the case of various fluids.
   b) Calculate the capillary rise in a glass tube of 3.2 mm diameter when immersed vertically in mercury. Take surface tension for mercury is 0.073 N/m. (9M+6M)

2. a) State and derive the momentum equation.
   b) Discuss path line, stream line, streak line and stream tube with neat sketches. (8M+7M)

3. a) Derive an expression for finding the major loss when the fluid flows through a pipe. Also give the formulae for various minor losses.
   b) A 300mm x 150mm inclined venturimeter carries water. The reading recorded by an inverse U- tube manometer is 400mm. The specific gravity of the manometric fluid is 0.8. If the loss between the inlet and throat is 0.3 times the kinetic head of the pipe, determine the discharge and coefficient of discharge. (8M+7M)

4. a) Show that the force exerted by a jet on a moving curved vane is greater than that on a moving flat plate.
   b) A metal plate of 10mm thickness and 200mm square is hung so that it can swing freely about the upper horizontal edge. A horizontal jet of water of 20mm diameter impinges with its axis perpendicular and 50mm below the edge of the hinge, and keeps it steadily inclined at 30^0 to the vertical. Find the velocity of the jet if the specific weight of the metal is $75.54 kN/m^3$
   (7M+8M)

5. a) Briefly explain the classification of power plants based on the storage characteristics.
   b) Two turbo-generators each of capacity 20,000 kW have been installed at a hydel power station. During a certain period the load on the hydel plant varies from 15000 to 35000 kW. Calculate total installed capacity, load factor, plant factor, utilization factor. (7M+8M)
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Code No: R21021 **R10** SET - 1

6. a) In the case of a pelton wheel prove that the hydraulic efficiency is maximum when the bucket speed is equal to half the velocity of the jet.
   b) Determine the efficiency of a Kaplan turbine developing 3000kW under a net head of 5m. It is provided with a draft tube with its inlet (diameter 3 m) set 1.6m above the tail race level. A vacuum gage connected to the draft tube indicates a reading of 5m of water. Assume draft tube efficiency as 78%. (10M+5M)

7. a) What are surge tanks? What is the purpose of providing surge tanks? Explain the different types present in it?
   b) A turbine develops 7460 kW under a head of 24.7 m at 135 rpm. What is the specific speed? What would be the normal speed and output under a head of 19.5m? (10M+5M)

8. a) Define Specific speed of a pump. Derive an expression for calculating the same. Give the classification of pumps based on specific speed.
   b) A centrifugal pump running at 1000 r.p.m delivers water against a head of 14.5m.The vanes are curved at an angle of 30^0 with its periphery. If the impeller diameter at the outlet is 30 cm and outlet width is 5 cm, determine the discharge. Take the Manometric efficiency as 95%. (10M+5M)

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1. a) Define Surface tension. Explain how does it varies with variation in temperature in fluids and explain how to determine the pressure intensity within a droplet and jet of liquid in excess of the outside pressure intensity.
   b) A plate 0.026 mm distant from a fixed plate, moves at 63 cm/sec and requires a force of 0.3 Kg (f)/mt^2 to maintain this speed. Determine the dynamic viscosity of the fluid between the plates. (10M+5M)

2. a) Define stream function and potential function and shown they intersect orthogonally.
   b) A 20cm diameter open cylinder, 30 cm high is subjected to a rigid body rotation about its central axis. The tank is half full with water. Find the maximum rotation to which the cylinder can be subjected such that the water does not spill from the cylinder. (8M+7M)

3. a) Show that the discharge of water through a sharp edged orifice shall be increased by about 38% if a short cylindrical mouthpiece of the same diameter is fitted in to it on the outside of the tank. Take coefficient of contraction as 0.62 and neglect the friction.
   b) A pipe having a length of 6 km and diameter 0.7m connects two reservoirs A and B, the difference between their water levels is 30m. Halfway along the pipe there is a branch through which water can be supplied to a third reservoir C. Taking f=0.024 determine the rate of flow of reservoir B when on water is discharged to reservoir C. (10M+5M)

4. a) Derive an expression for maximum efficiency for a series of flat plates mounted on the periphery of a wheel and find its value also.
   b) A jet of water 75 mm diameters having a velocity of 20m/s, strikes normally a flat smooth plate. Determine the thrust on the plate (i) If the plate is at rest.(ii) If the plate is moving in the same direction as that of the jet with a velocity of 5m/s. Also find the work done per second on the plate in the each case and the efficiency of the jet when the plate is moving. (7M+8M)

5. a) Distinguish between base-load power plant and peak-load power plant.
   b) A run-of-river hydroelectric power station is proposed across a river at a site where a net head of 20 m is available on the turbine. The river carries a sustained minimum flow of 25 cumec in dry weather and behind the power station sufficient pondage is provided to supply daily peak load of demand with a load factor of 70%. Assuming the plant efficiency as 55%, determine the maximum generating capacity of the generator to be installed at the power house. If the daily load pattern indicates 20 hours average load and 4 hours of peak load, determine the volume of pondage to be provided to supply the daily demand. (7M+8M)
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Code No: R21021 **R10** SET - 2

6. a) With the help of a neat sketch explain the working of a Kaplan Turbine.
   b) An inward flow reaction turbine with radial discharge with an overall efficiency of 85% is required to develop 180kw. The head is 10m; peripheral velocity is $0.96\sqrt{2gh}$; radial velocity of flow is $0.36\sqrt{2gh}$. The wheel is to make 180rpm. The hydraulic losses in the turbine are 25% of the available energy. Determine (i) the angle of the guide blade at inlet (ii) the wheel vane angle at inlet (iii) the diameter of the wheel (iv) the width of the wheel at inlet. (7M+8M)

7. a) Explain in detail the various characteristic curves present in the case of turbines.
   b) A turbine develops 7460 kW under a head of 24.7m at 135 rpm. What is the specific speed? What would be its normal speed and output under a head of 20.5m? (10M+5M)

8. a) With the help of a neat sketch explain the component parts and working of a Reciprocating pump.
   b) A centrifugal pump has the following characteristics: outer diameter of the Impeller =800mm: width of impeller vanes at out let=40mm. The impeller runs at 550rpm and delivers $0.98m^3$ of water per second under an effective head of 35m. A 500kW motor is used to drive the pump. Determine various efficiencies of the Pump. Assume the water enters the impeller radially. (8M+7M)

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1. a) Prove that the pressure is same in all directions at a point in static fluid. Give some examples where this principle is applied.
   b) Through a very narrow gap of height h, a thin plate of large extent is pulled at a velocity of V. On one side of the plate is oil of viscosity μ_1 and on the other side of viscosity μ_2.
   Calculate the position of the plates so that i) the shear force on the two sides of the plate is equal ii) The pull required to drag the plate is minimum. (10M+5M)

2. a) Explain the various forms of deformations that a fluid particle undergoes during a flow and derive the condition for the flow to be irrotational.
   b) Oil of specific gravity 0.75 flows through an expanding bend that turns the liquid through 120^o. The upstream diameter is 600 mm and downstream diameter is 750 mm. The flow through the bend is 25 m^3/s. Neglecting energy losses through the bend, determine the force components necessary to support the bend, if the inlet pressure is 70 kPa. (8M+7M)

3. a) Derive an expression for finding the discharge through an orifice.
   b) The population of a city is 800000 and it is to be supplied with water from a reservoir 6.4 km away. Water is to be supplied at the rate of 140lts/head/day and half the supply is to be delivered in 8 hours. The full supply level of the reservoir is RL 180.00 and its lowest water level is RL 105.00. The delivery end of the main is at RL 22.50 and the head required there is 12m. Find the diameter of the pipe. Take f=0.04. (7M+8M)

4. a) Show that the efficiency of a free jet striking normally a series of flat plates mounted on the periphery of a wheel never exceeds 50%.
   b) A water wheel has a number of hemispherical vanes equally spaced on the periphery. A jet of diameter 300 mm having a velocity of 6m/s. Determine the work done on the wheel. (8M+7M)

5. a) Show that the capacity factor is equal to the product of the load factor and utilization factor.
   b) A run-of-river hydroelectric power plant is installed on a river having a minimum flow of 12 m^3/s. If the plant is used as a peak load plant operating only for 5 hours a day, determine the firm capacity of the plant i) without pondage, ii) with pondage but allowing 10% of the water to be lost in evaporation and other losses. Head at the plant is 16 m and the plant efficiency may be assumed as 75%. (8M+7M)
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Code No: R21021 **R10** SET - 3

6. a) Write a brief note on classification of turbines.
   b) A pelton wheel has to be designed for the following data: power to be developed =6000 kW, Net head available = 400 m, speed = 550 rpm, Ratio of jet diameter to the wheel diameter = 1/10 and overall efficiency = 85%. Find the number of jets, diameter of jet, diameter of the wheel and quantity of water required. (7M+8M)

7. a) Briefly explain the various factors on which the selection of suitable type of turbine is usually governed by.
   b) A turbine is to operate under a head of 25m at 200 rpm. If the discharge is $9m^3/s$ and the turbine efficiency is 90%, calculate the power generated by the turbine, specific speed of the turbine and performance of the turbine under a head of 20m. Also state the type of the turbine. (8M+7M)

8. a) Derive an expression for the work done by the centrifugal pump
   b) What is meant by Negative Slip? When does this occurs?
   c) A double acting reciprocating pump, running at 40 rpm is discharging 1.0 m^3 of water per minute. The pump has a stroke of 400mm. The diameter of the piston is 200mm. The delivery and the suction heads are 20m and 5m respectively. Find the slip of the pump and power required to drive the pump. (6M+4M+5M)

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1. a) Explain in detail how can you measure the gage pressure in the case of the two types of single column manometers.
   b) Carbon-tetra chloride has a mass density of 1594 kg/m^3. Calculate its mass density, specific volume in the metric, and the English gravitational system of units. Also, calculate its specific gravity. (10M+5M)

2. a) Sate Euler's equation of motion and derive Bernoulli's equation from Euler's equation by clearly stating the assumptions made.
   b) The stream function for a two dimensional plane flow is given by $\psi = 2xy$. Determine the velocity potential function if it exists. Also determine the flow rate taking place between points (0, 0) and (2, 1). (10M+5M)

3. a) Derive an expression for finding the rate of flow through a venturimeter.
   b) A pipe 50 mm in diameter is 6m long and the velocity of flow of water in the pipe is 2.4 m/s. What loss of head and the corresponding power would be saved if the central 2m length of pipe was replaced by 75 mm diameter pipe, the change of section being sudden? Take f=0.04 for the pipes of both the diameters. (8M+7M)

4. a) Derive an expression for finding the maximum efficiency when a jet is striking moving curved vane at its centre.
   b) A jet of water moving at 15m/s impinges on a symmetrical concave vane shaped to deflect the jet through 140^0. If the vane is moving at 6m/s, find the angle of the jet so that there is no shock at inlet. Also determine the absolute velocity of exit in magnitude and direction and the work done per unit weight of water. (8M+7M)

5. a) Discuss the general classification of hydropower plants according to different considerations.
   b) A run-of-river plant with an installed capacity of 14000kW operates at 25% load factor when it serves as a peak load station. What should be the minimum discharge in the stream so that it may serve as the base load station? The plant efficiency may be taken as 80% when working under a head of 20 m. Also calculate the maximum load factor of the plant when the discharge in the stream is 30m^3/s. (10M+5M)
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Code No: R21021 **R10** SET - 4

6. a) What is a draft tube? What is the purpose of providing a draft tube? What are the different types of draft tubes available? Which one is efficient and why?
b) A pelton wheel has a mean bucket speed of 12m/s and is supplied with water at a rate of 800 litres per second under a head of 40 m. If the bucket deflects the jet through an angle of 165^0, find the power developed by the turbine and its hydraulic efficiency. Take the coefficient of velocity as 0.98. Neglect friction in the bucket. Also determine the overall efficiency of the turbine if its mechanical efficiency is 80%. (8M+7M)

7. a) Explain the terms specific speed, unit speed and unit power as applied to hydraulic turbines. Deduce the expressions to indicate their values.
b) A water turbine develops 150 kW at 250 rpm, under a head of 16m. Determine the scale ratio and the speed of a similar machine which will generate 680 kW when working under a head of 25m. (9M+6M)

8. a) With the help of neat sketches explain about the multi-stage centrifugal pumps.
b) A double acting reciprocating pump has piston of diameter 250 mm and piston rod of diameter 50 mm which is on one side only. Length of piston stroke is 350 mm and speed of crank moving the piston is 60 rpm. The suction and delivery heads are 4.5m and 18 m respectively. Determine the discharge capacity of the pump and the power required to drive the pump. (10M+5M)