Code No: R1621034 **R16** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, October/November - 2018
FLUID MECHANICS & HYDRAULIC MACHINES
(Com to ME & Mining Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) Define Viscosity and write the types of viscosity? (3M)
   b) Write Darcy Weisbach equation? (2M)
   c) Define stream lined body? (2M)
   d) Write about work done and efficiency ? (2M)
   e) Write about NPSH? (2M)
   f) Define cavitation and water hammer? (3M)

PART -B

2. a) Explain the phenomenon of surface tension on the top surface of liquids. What are the examples of surface tension. (5M)
   b) A glass tube of internal diameter 4 mm is immersed in a liquid of specific gravity 12.2 and surface tension 0.55 N/m. The angle of contact with the glass is 120^0. Calculate capillary rise or depression in the tube. (9M)

3. a) A pipe 300 meters long has a slope of 1 in 100 and tapers from 1.20 m diameter at the high end to 0.6 m diameter at the low end. The rate of flow of water through the pipe is $0.10 m^3$/sec. If the pressure at the high end is 73.575 kPa, find the pressure at the low end. Neglect losses. (7M)
   b) Two reservoirs are connected by three pipes laid in parallel, their respective diameters being d, 2d, and 3d. These are all of the same length l. If f is the same for all the pipes find the discharge through the larger pipes if the discharge through the smallest is 0.05 m^3/sec. (7M)

4. a) Oil with a free stream velocity of 3 m/s flows over a thin plate 1.25-m wide and 2 m long. Determine the boundary layer thickness and the shear stress at mid – length and calculate the total, double-sided resistance of the plate. Take p = 860 kg/m^3 and v= 10^{-3} m^2/s (8M)
   b) Write about dimensionless numbers? (6M)

5. a) A 15 cm diameter jet of water with a velocity of 15 m/s strikes a plane normally. If the plate is moving with a velocity of 6 m/s in the direction of the jet calculate the work done per second on the plate and the efficiency (η) of energy transfer. (7M)
   b) Derive an expression for the force exerted by the jet of water on a stationary inclined plate. (7M)
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6. a) A centrifugal pump having an overall efficiency of 80% delivers 1850 liters of water per minute to a height 0f 20 meters through a pipe of 100mm diameter and 95 meters length. Taking f = 0.0075, find the power required to drive the pump. (7M)

   b) A double acting reciprocating pump of cylinder diameter 300mm and stroke of 400mm is situated at a height of 3.50 meters above the sump water level. The suction pipe is 150mm in diameter and 6 meters long. If the pump runs at 25 rpm, calculate the absolute pressure head in the cylinder on the suction side at the commencement of the stroke. Take atmospheric pressure head = 10.3 meters of water. (7M)

7. a) Show that for the maximum efficiency, the bucket speed of a pelton wheel should be equal to one half of the jet speed. (7M)

   b) A hydraulic turbine under a head of 25 metres develops 7260 kW running at 110 rpm. What is the specific speed of the turbine? What type of turbine is this? Find also the normal speed and output if the head on the turbine is reduced to 20 metres. (7M)

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PART –A

1. a) Define Vapour pressure and Surface tension?? (2M)
b) Write Euler's equations for flow along a stream line? (3M)
c) Write about momentum integral equation? (2M)
d) Write about types of vanes? (2M)
e) What are the methods adopted to increase the efficiency of a pump? (2M)
f) Write about governing of turbines? (3M)

PART -B

2. a) Describe the differential manometer with neat sketch. (6M)
b) The right limb of a simple U- tube manometer containing mercury is open to the atmosphere while the left limb is connected to a pipe in which a fluid of sp.gr. 0.9 is flowing. The centre of the pipe is 12 cm below the level of mercury in the right limb. Find the pressure of fluid in the pipe if the difference of mercury level in the two limbs is 20 cm. (8M)

3. a) Explain pipes in series and pipe in parallel with a neat sketch. Also write about Hydraulic Gradient line and Total energy line. (7M)
b) A pumping plant forces water through a 500 mm diameter main, the friction head being 30 metres. In order to reduce the power consumption, it is proposed to lay another main of appropriate diameter along the side of the existing one, so that two pipes may work in parallel for the entire length and reduce the friction head to 10 metres only. Find the diameter of the new main if with the exception of the diameter, it is similar to the existing one in every respect. (7M)

4. a) Find the displacement thickness and wall shear stress for the velocity distribution in a boundary layer (u / U) = (y / δ) where U is the Velocity and δ is the boundary layer thickness. (7M)
b) A flat plate of 2.0 m width and 4.0 m length is kept parallel to air flowing at a velocity of 5 m/s. Determine the length of plate over which the boundary layer is laminar, shear at the location which boundary layer ceases to be laminar and total force on both sides on that portion of plate where the boundary layer is laminar. Take p = 1.2 kg/m^3 and v = 1.47x10^{-5} m^2/s. (7M)
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5. a) A 20 cm diameter jet of oil (Relative Density = 0.9) strikes a flat plate at an angle of 250 to the normal. The plate is moving at a velocity of 3 m/s in the direction of the jet. Calculate the absolute velocity of the jet if the resultant force exerted on the plate is 2500 N. (7M)

   b) A jet water 15 cm in diameter strikes a curved blade at 20 m/s velocity. The inlet angle and the outlet angles of the vane are 0^0 and 45^0 respectively. Determine the resultant force exerted on the blade when (i) the jet is stationary and (ii) the blade moves against the direction of the water at 5 m/s. Neglect friction along the blade. (7M)

6. a) A centrifugal pump discharge 560 liters of water per second has to develop a head of 10 meters, the speed of rotation of the impeller being 700rpm. The manometric efficiency is 85% and the loss of head in the pump due to friction is $0.025\ V_1^{\ 2}$ meters of water, where V_1 is the velocity with which the water leaves the impeller. Assume that the velocity of flow through the impeller is constant at 2.50 meters per second and that there is no velocity of whirl at inlet. Determine (i) The diameter of the impeller (ii) the outlet area (iii) The vane angle at the outlet edge of the impeller. (7M)

   b) A single acting reciprocating pump has a plunger of diameter 0.3m and stroke of length 0.4m. If the speed of the pump is 60 rpm and coefficient of discharge is 0.97, determine the percentage slip and actual discharge of the pump. (7M)

7. a) A Pelton wheel working under a head of 52 metres develops a shaft power of 92 kW at a speed of 250 rpm. If the overall efficiency is 82.5% and Cv =0.98, find the jet diameter, the diameter of the bucket circle, the size of the buckets and the number of buckets required. Assume maximum efficiency condition that the peripheral velocity is 0.47 times the velocity of the jet. (7M)

   b) What is the necessity of a Surge Tank in turbines? Explain different types of Surges with the aid of neat diagrams. (7M)

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PART –A

1. a) Write about hydrostatic law? (2M)
   b) Write Bernoulli's equation for flow along a stream line? (2M)
   c) Write the phenomenon of boundary layer separation? (3M)
   d) Write about hydrodynamic force? (2M)
   e) What are the different efficiencies of a centrifugal pump? (2M)
   f) Write about fluidics? (3M)

PART –B

2. a) What is the difference between U-tube differential manometer and inverted U-tub e differential manometer? Where are they used? (7M)
   b) A shaft 80 mm in diameter is being pushed through a bearing sleeve 80.20mm in diameter and 300 mm long, The clearance is filled with oil having a kinematic viscosity of 0.005 m^2/s and specific gravity 0.90. If the shaft moves axially at 0.50m/s. find the resistance offered by the oil on the shaft. (7M)

3. a) Explain (i) Stream line (ii) vorticity (iii) Irrotational Flow (iv) Streak line. (6M)
   b) A pipe of diameter 200 mm conveys a discharge of 2250 litres of water per minute and has a pressure of 15.70 kPa at a certain section. Find the total energy head with respect to a datum of 5 metres below the pipe. (8M)

4. a) In a laminar boundary layer over a plate the velocity distribution is given by $(u/U_m) = (3/2)(y/d) - (1/2)(y^2/d^2)$. Find the boundary layer thickness, wall shear stress and coefficient of drag. (8M)
   b) What is the physical significance of displacement thickness of boundary layer theory? (6M)

5. a) A jet 200 mm diameter moving at a velocity of 20 metres per second impinges normally on a series of flat vanes mounted over a wheel. If the velocity of the vanes is 8 metres per second, find (i) the force exerted by the jet on the wheel, (ii) the work done by the jet on the wheel per second, and (iii) the hydraulic efficiency (7M)
   b) Derive an expression for the force exerted by a jet striking the curved plate at one end tangentially when the plate is symmetrical. (7M)
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6. a) A centrifugal pump has vanes which are radial at the outer periphery. The impeller has an outer diameter of 20 cm and a width of 3 cm at that diameter. If the discharge is 1800 L/min and the net head produced is 3.5 m, calculate the (i) rotational speed of the impeller and (ii) magnitude and direction of absolute velocity at exit. Manometric efficiency can be assumed as 0.85. (7M)

   b) A single acting reciprocating pump has a plunger diameter of 100 mm and a stroke of 200mm. The suction pipe is 80 mm in diameter and 6 meters long. The pump is situated at a height of 3 meters above the sump water level. If the pump runs at 30rpm, calculate the absolute pressure head in the cylinder at the beginning of the suction stroke. The atmospheric pressure head = 10.30 meters of water. (7M)

7. a) A reaction turbine works at 460 rpm under a head of 110 metres. Its diameter at inlet is 1150 mm and the flow area is 0.03 metre^2. The angles made by the absolute velocity and relative velocity at inlet are respectively 18^0 and 50^0 with the tangential velocity. Determine (i) The volume flow rate (ii) The power developed (iii) The efficiency. Assume whirl at outlet to be zero (7M)

   b) A turbine develops 7725 kW under a head of 28 metres at 140 rpm. Calculate the specific speed of the turbine and state the type of turbine. (7M)

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PART –A

1. a) Write about Pascal's law? (2M)
   b) Write the types of flows? (2M)
   c) State the applications of stream lined body? (3M)
   d) Write about impact of jet? (3M)
   e) Write about manometric head? (2M)
   f) Classify turbines? (2M)

PART –B

2. a) A clean tube of internal diameter 3mm is immersed in a liquid with a surface tension of 0.48N/m. The angle of contact of the liquid with the glass can be assumed to be 130^0. The density of the liquid is 13600 Kg/m^3. What would be the level of the liquid in the tube relative to the free surface of the liquid outside the tube? (10M)
   b) Write about stability of floating body? (4M)

3. a) State and explain continuity equation. Derive continuity equation for one dimensional flow. (7M)
   b) A 300 mm diameter pipe conveying water branches into two pipes of diameter 250 mm and 200 mm and respectively. If the average velocities in the 300 mm and the 200 mm pipes be 2.5m/sec and 1 m/sec, calculate the velocity in the 250 mm pipe. (7M)

4. a) The velocity distribution in the boundary layer was found to fit the equation $(u/U) = (y/d)^{1/7}$. Find the displacement thickness. (7M)
   b) Explain about Similitude and modelling? (7M)
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5. a) A 150mm diameter jet moving at 25 meters per second impinges on a series of vanes moving at 12.5 meters per second in the direction of the jet. The jet leaves the vanes at 60^0 with the direction of motion of the vanes. Calculate (i) the force exerted by the jet in the direction of motion of the vanes and (ii) work done by the jet per second. (7M)

   b) A jet of water delivers 0.56 m^3/sec with a velocity of a 24 metres/sec and impinges tangentially on a vane moving in the direction of the jet with a velocity of 12 metres per second. The value is so shaped that if stationary it would deflect the jet through an angle of 45^0. Through what angle will the jet be actually deflected? What driving force will be exerted on the vane in the direction of motion? (7M)

6. a) A centrifugal pump runs at 800 rpm and delivers 5000 L/min against a head of 7 m. The impeller has an outer diameter of 25 cm and a width of 5 cm at the outlet. If the backward curved vane at the outlet makes an angle of 45^0, determine the manometric efficiency. What is the specific speed of the pump? (7M)

   b) A single acting reciprocating pump has a piston diameter of 150mm and stroke length of 350mm. The center of the pump is 3.5m above the water surface in the sump and 22m below the delivery water level. If the pump is working at 30 rpm, determine the power required to drive the pump. (7M)

7. a) A Kaplan turbine working under a head of 18 metres develops 18390 kW at an overall efficiency of 85%. The boss diameter is 0.3 times the runner diameter. If the velocity of flow is 9.05 metres per second, calculate the discharge and the diameters of the runner and the boss. (7M)

   b) A turbine is to operate under a head of 30 metres at 250 rpm. The discharge is 10.5 m^3/sec. If the efficiency is 85%, determine (i) Power generated, (ii) The specific speed of the turbine, (iii) Type of turbine, (iv) Performance under a head of 25 metres. (7M)