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

II B. Tech I Semester Supplementary Examinations, September - 2014
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) Drive equation of Newton's law of viscosity and kinematic viscosity and hence obtain their dimensions in SI units and CGS units?
   b) Two parallel flat plates are placed 1.25cm apart. A 0.25cm thick plate of 0.2m^2 area is being towed in glycerin filled between the above plates with a constant force of 1kg or (9.81N). Calculate the towing speed of the plate when it is held equidistant from the two parallel plates. Take m=0.01gm/cm.sec.

2. a) State and prove the hydrostatic law and give some example where this principle is applied.
   b) A piece of pipe of 5.25cm internal diameter and 15cm long slides down a vertical shaft of 5.0 cm diameter at a constant speed of 0.1m/s. A vertical force 1.5kg (14.7N) is required to pull the pipe back up the shaft at the same constant speed. Calculate the approximate viscosity of air which fills the small gap between the pipe and shaft?

3. a) Briefly explain about Differential U-tube manometer, micro manometer and Barometer
   b) Calculate the capillary effect in millimeter in a glass tube of 4mm diameter when immersed (i) in water (ii) in mercury. The temperature of the liquids is 20^{o}C in contact with air respectively 0.0075kg/m and 0.050kg/m. The contact angle for water θ=0^o and for mercury θ=130^o

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4. a) For the velocity components in a fluid flow given by u=2y+y/ $\sqrt{(x^2+y^2)}$;

   v= -2x- x/ $\sqrt{(x^2+y^2)}$, show that the flow is possible. Obtain the relevant stream function.

   b) A jet of water 20 mm diameter nozzle leaves the nozzles tip with 15 m/s and is directed vertically upwards. If the jet remains circular, Find out its diameter at a point 3m above the nozzle tip. Neglect any loss of energy.

5. a) Describe an Orifice meter and find an expression for measuring discharge of fluid through a pipe?

   b) A venturimeter has its axis vertically the inlet and the throat diameter being 150mm and 75mm respectively. The throat is 225 mm from inlet and venturimeter constant is 0.96, petrol of specific gravity 0.78 flows up through the meter at a rate of 0.029 m^3/s. Find the pressure difference between inlet and throat?

6. a) Derive Hagen-Poiseuille equation and state the assumptions made?

   b) An oil of viscosity 1poise and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300m. The rate of flow of liquid is 0.0035 $m^3\ s^{-1}$. Find the pressure drop in a length of 300 m and shear stress at the wall.

7. a) Explain the characteristic curves of the turbines

   b) What is Cavitation? How can we prevent the effect of Cavitation?

8. a) Enumerate the salient points of difference between the centrifugal and reciprocating pumps.

   b) Discuss relative merits and demerits of hydro-power as compared to other power sources.

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1. a) State and prove the hydrostatic law and give some example where this principle is applied.
   b) A thin plate is placed between two flat surfaces h cm apart such that the viscosity of liquid on the top and bottom of the plate are μ_1 and μ_2 respectively. Determine the position of the thin plate such that the viscous resistance to uniform motion of the thin plate is minimum.

2. a) Differentiate between micro-manometers and inclined tube manometers? And briefly enumerate with neat sketch about Bourdon gauge.
   b) A circular plate 3m in diameter is submerged in water so that the greatest and least depths below the free surface are 2m and 1m respectively. Find: (i) total pressure force on one side of the plate and (ii) the position of the centre of pressure.

3. a) Derive Bernoulli's equation for flow along a stream lines. State the significance of each term of Bernoulli's equation.
   b) The velocity in an incompressible flow is given by $V=(6x + yz^2)i + (3t+xy^2)j + (xy-2xyz-6tz)k$. i) Verify whether the continuity equation is satisfied ii) Determine the acceleration vector at point A(1,1,1) at t = 0;

4. a) Derive an expression for discharge through a venturimeter, using a neat sketch.
   b) A 2m long pipeline tapers uniformly from 10cm diameter to 20cm diameter at its upper end. The pipe centre line slopes upwards at an angle of 30^0 to the horizontal and the flow direction is from smaller to bigger cross-section. If the pressure gauges installed at the lower and upper ends of the pipeline read 200 kPa and 230 kPa respectively. Determine the flow rate and the fluid pressure at the mid-length of the pipeline. Assume no energy losses.

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5. a) Derive Hagen-Poiseuille equation and state the assumptions made?

   b) The diameter of a pipe bend is 30cm at inlet and 15cm at outlet and the flow is turned through 120^0 in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5m below the centre of the inlet section. Total volume of water in the bend is 0.9 m^3. Neglecting friction, calculate the magnitude and direction of the force entered on the bend by water flowing through it at 250 lit/sec and when the inlet pressure is 0.15 $N.mm^2$.

6. a) A 50mm diameter jet having a velocity of 18 m/s impinges without shock on a flat plate inclined at angle of 30° to the axis of the jet. If the plate is moving at 5 m/s in the direction of jet, make calculations for the normal force exerted on the plate, work done and the efficiency of the plate-jet system.

   b) Show that when a jet of water impinges on a series of curved vanes, maximum efficiency is obtained when the vane is semi-circular in section and the velocity of vane is half that of jet.

7. a) Explain geometric, kinematic and dynamic similarities.

   b) Explain the phenomenon of water hammer.

8. a) What are the different performance characteristics of centrifugal pumps and also give commonly experienced troubles during the operation of centrifugal pumps.

   b) What is NPSH? Explain.

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1. a) Explain the practical significance of the following liquid properties
   i) Viscosity ii) Capillarity iii) Surface tension iv) vapour Pressure
   b) A oil of mean density 880 kgf/m^3 flows under a head of 30 cm through 3000m of pipe of 30 cm diameter owing to cooling viscosity changes along the length and may be taken as 5.75 poise over the first 1500m , and 11.5 poise over the second 1500m. Determine the flow in m^3/s. Neglecting entrance and exit losses.

2. a) Prove that the pressure at point in a fluid at rest has the same magnitude in all direction? And state the Pascal's law? Give some examples where this principle is applied.
   b) A piezometer tube is connected to a tank full of water 75cm above the bottom of the tank. The manometer has carbon bisulphate with specific gravity 1.9 as measuring fluid. The tube gives a reading of 65cm. How high is the free water surface above the bottom of the tank and what is the pressure on the bottom of the tank.

3. a) Derive Bernoulli's equation from Euler's equation of motion for a stream tube. and discuss the assumptions underlying Bernoulli's equation.
   b) A pipe 300m long has a slope of 1 in 100 and tapers from 1.5m diameter at the high end to 0.75m diameter at the low end. Quantity of water flowing is 100 lit/sec. If pressure at the high end, is 50 Kpa Neglect friction. Find pressure at low end.

4. a) Derive an expression for discharge through a Venturimeter meter, using a neat sketch.
   b) A conveying pipeline carrying water has to be laid over a hump. The diameter at the inlet and outlet of the pipe are 70cm and 50cm respectively. The pressure at the inlet end is 335 kN/m^2, difference in level between inlet and out outlet is 1.2m and friction loss in the pipe line is 1/9 th of the velocity head at the exit. If the discharge carried is 2.85 m^3/s, find the pressure at the exit.

5. a) For Φ=x(2y-1), determine corresponding stream function ψ.
   b) A jet of water 5cm diameter strikes a curved vane at rest with a velocity of 30 m/s and is deflected through 135^0 from its original direction. Neglecting friction, compute resultant force on the blade in magnitude and direction?

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6. a) Derive Hagen-Poiseuille equation and state the assumptions made?
   b) An oil of viscosity 1.2 poise and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300m. The rate of flow of liquid is 0.0035 m^3 s^{-1}. Find the pressure drop in a length of 300 m and shear stress at the wall.

7. a) Why is the efficiency of Kaplan turbine nearly constant irrespective of speed variation under load?
   b) A Francis turbine has a wheel diameter of 1.2m at the entrance and 0.6 m at the exit. The blade angle at the entrance is 90^o and the guide vane angle is 15^o. The water at the exit leaves the blades without any tangential velocity. The available head is 30m and the radial component of flow velocity is constant. What would be the speed of wheel in rpm and blade angle at the exit? Neglect friction.

8. Write a short notes on the following
   a) Governing of turbines
   b) Losses in pumps.

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1. a) State the principle of pressure measurement by a manometer. Explain the difference between a simple and differential manometer.
   b) A cylinder of 0.12 m radius rotates concentrically inside a fixed hollow cylinder of 0.13m radius. Both the cylinders are 0.3m long. Determine the viscosity of the fluid which fills the space between the cylinders if a torque of 0.88 Nm is required to maintain an angular velocity of 2π rad/s.

2. a) Derive Euler's equation of motion along a streamline, and hence derive the Bernoulli's theorem.
   b) Two reservoirs are connected by three pipes laid in parallel. The pipe diameters are respectively 10cm, 20cm, and 30cm and they are of the same length. If discharge through 10cm pipe is 0.1 m^3/s, calculate the discharge through the larger pipes. Assume the friction coefficient 'f' to be same for the pipes.

3. a) Show that when a jet of water impinges on a series of curved vanes, maximum efficiency is obtained when the vane is semi-circular in section and the velocity of vane is half that of jet.
   b) A 50mm diameter jet having a velocity of 18 m/s impinges without shock on a flat plate inclined at angle of 30° to the axis of the jet. If the plate is moving at 5m/s in the direction of jet, make calculations for the normal force exerted on a plate, work done and efficiency of the plate-jet system.

4. a) Why is the efficiency of Kaplan turbine nearly constant irrespective of speed variation under load?
   b) Calculate the friction drag on a plate 15cm wide and 45cm wide long placed longitudinally in a stream of oil (specific gravity 0.925 and kinematic viscosity 0.9 stokes) flowing with a free stream velocity of 6 meters per second. Also find the thickness of the boundary layer and shear stress at the trailing edge.

5. a) Give the elements of hydro electric power station? What are the different methods of classifying the hydro-electric power plants?
   b) Discuss the relative merits and demerits of hydro-power as compared to other power sources

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6. a) Deduce an expression for the specific speed of hydrodynamic machine and point out how the classification of hydrodynamic runners is based on the specific speed.
   b) A turbine develops 7350 KW under a head of 25 meters at 135 rpm. Calculate the specific speed of the turbine and state the type of turbine.

7. a) Enumerate the salient points of difference between the centrifugal and reciprocating pump.
   b) A centrifugal pump with an impeller diameter 30cm runs at 1450 rpm and delivers 2.3 m^3/ min against a head of 16m. Estimate the head and size of a geometrically similar pump which would deliver half the quantity while running at the same speed.

8. Write short notes on the following:
   a) Cavitation in turbines
   b) Reynolds Experiment
   c) Difference between the centrifugal and reciprocating pumps.

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