Code No: RT22034 **R13** SET - 1

II B. Tech II Semester Regular Examinations, April/May - 2016
FLUID MECHANICS AND HYDRAULIC MACHINERY
(Com. to ME, AME)

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 **THREE** Questions from **Part-B**

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PART –A

1. a) Explain atmospheric, gauge and vacuum pressure. (4M)
   b) Describe the condition for Irrotational flow. (3M)
   c) What is a bluff body? What is its application? (4M)
   d) What are the velocity triangles? Draw them and explain. (4M)
   e) What is NPSH? Explain. (4M)
   f) Discuss the applications of sensors and oscillators. (3M)

PART -B

2. a) Define the following fluid properties:
   Density, weight density, specific volume and specific gravity of a fluid. (8M)
   b) An oil film of thickness 1.5 mm is used for lubrication between a square plate of size 0.9 m × 0.9 m and an inclined plane having an angle of inclination 20^0 . The weight of the square plate is 392.4 N and it slides down the plane with a uniform velocity of 0.2 m/s. Find the dynamic viscosity of the oil. (8M)

3. a) Define the equation of continuity. Obtain an expression for continuity equation for a one dimensional flow (8M)
   b) Water is flowing through a pipe having diameters 30 cm and 15 cm at the bottom and upper end respectively. The intensity of pressure at the bottom end is 29.43 N/cm^2 and the pressure at the upper end is 14.715 N/cm^2. Determine the difference in datum head if the rate of flow through pipe is 50 lit/s. (8M)

4. a) What is boundary layer separation? Explain the control of it. (8M)
   b) Distinguish among geometric, kinematic and dynamic similarities. (8M)

5. a) Find the expression for the force exerted by the jet on a flat vertical plate moving in the direction of the jet. (8M)
   b) A jet of diameter 150mm strikes a flat plate normally with a velocity of 20m/sec. The plate is moving with a velocity of 5m/sec in the direction of the jet and away from the jet. Find (8M)
   i) The force exerted by the jet on the plate
   ii) Work done by the jet on the plate per second
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6. a) Define a centrifugal pump. Explain the working of a single-stage centrifugal pump with sketches. (8M)
   b) The internal and external diameters of the impeller of a centrifugal pump are 300 mm and 600 mm respectively. The pump is running at 1000 r.p.m. The vane angles at inlet and outlet are 20^0 and 30^0 respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water. (8M)

7. a) What do you mean by gross head, net head and efficiency of turbine? Explain the different types of efficiencies of a turbine. (8M)

   b) A Pelton wheel has a mean bucket speed of 35 m/s with a jet of water flowing at the rate of 1 m^3/s under a head of 270 m. The buckets deflect the jet through an angle of 170°. Calculate the power delivered to the runner and the hydraulic efficiency of the turbine. Assume co-efficient of velocity as 0.98. (8M)

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PART –A

1. a) Distinguish between floating body and submerged body. (4M)
   b) Explain HGL and TEL with the help of a neat sketch. (4M)
   c) Explain what dynamic similarity is. (3M)
   d) What is hydrodynamic force? Explain. (3M)
   e) Explain the working principle of Reciprocating pump. (4M)
   f) What is meant by governing of a turbine? When it is required. (4M)

PART -B

2. a) What is metacentric height? Derive the expression for it. (8M)
   b) In a stream of glycerine in motion, at a certain point the velocity gradient is 0.25 metre per sec per metre. The mass density of fluid is 1268.4 kg per cubic metre and kinematic viscosity is 6.30 × 10−4 square metres per second. Calculate the shear stress at the point. (8M)

3. a) Explain the terms: (8M)
   (i) Path line (ii) Streak line
   (iii) Stream line, (iv) Stream tube.
   b) A 40 cm diameter pipe, conveying water, branches into two pipes of diameter 30 cm and 20 cm respectively. If the average velocity in the 40 cm diameter pipe is 3 m/s, find the discharge in this pipe. Also determine the velocity in 20 cm pipe if the average velocity in 30 cm diameter pipe is 2 m/s. (8M)

4. a) What do you mean by boundary layer separation? What is the effect of pressure gradient on boundary layer separation? (8M)
   b) Define the following dimensionless numbers with their suitability: (8M)
   (i) Reynold's Number
   (ii) Weber Number.

5. a) Derive an expression for the force exerted by a jet of water on an inclined fixed plate in the direction of the jet. (8M)
   b) A jet of water of diameter 50mm moving with a velocity of 20m/sec strikes a fixed plate in such a way that the angle between the jet and the plate is $60^{0.}$ (8M)
   Find the force exerted by the jet on the plate.
   i) In the direction normal to the plate. ii) In the direction of the jet.
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Code No: RT22034 **R13** SET - 2

6. a) Differentiate between the volute casing and vortex casing for the centrifugal pump with the aid of neat sketches. (8M)
   b) A centrifugal pump is running at 1000 r.p.m. The outlet vane angle of the impeller is 30^0 and velocity of flow at outlet is 3 m/s. The pump is working against a total head of 30 m and the discharge through the pump is $0.3m^3/s$. If the manometric efficiency of the pump is 75 %, determine: (i) the diameter of the impeller, and (ii) the width of the impeller at outlet. (8M)

7. a) How will you classify the turbines? What is the basis for classification? Explain in detail. (8M)
   b) A Pelton wheel is to be designed for the following specifications. (8M)
   Power = 735.75 kW S.P, Head = 200 m, Speed = 800 r.p.m., η_o = 0.86 and jet diameter is not to exceed one-tenth the wheel diameter. Determine: (i) Wheel diameter, (ii) The number of jets required, and (iii) Diameter of the jet. Take C_v=0.98 and speed ratio =0.45.

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PART –A

1. a) What is Pascal's law? Explain. (4M)
   b) Distinguish circulation and vorticity. (4M)
   c) Explain momentum integral equation. (3M)
   d) Analyze the flow over radial vanes. (4M)
   e) What is specific speed of a pump? Give the equation for it. (3M)
   f) What do you mean by characteristic curves of turbines? (4M)

PART -B

2. a) What is the difference between dynamic viscosity and kinematic viscosity. State their units of measurements. (8M)
   b) Two plates are placed at a distance of 0.15 mm apart. The lower plate is fixed while the upper plate having surface area 1.0 m^2 is pulled at 0.3 m/s. Find the force and power required to maintain this speed, if the fluid separating them is having viscosity of 1.5 poise. (8M)

3. a) Distinguish between: (i) Steady flow and un-steady flow, (ii) Uniform and non-uniform flow, (iii) Compressible and incompressible flow, (iv) Rotational and irrigational flow (v) Laminar and turbulent flow. (8M)
   b) A pipe, through which water is flowing, is having diameters 40 cm and 20 cm at the cross-sections 1 and 2 respectively. The velocity of water at section 1 is 5.0 m/s. Find the velocity head at the sections 1 and 2 and also rate of discharge. (8M)

4. a) What are the boundary conditions that must be satisfied by a given velocity profile in laminar boundary layer flows? Explain. (8M)
   b) Define the following dimensionless numbers with their suitability: (8M)
   (i) Froude's Number
   (ii) Euler's Number
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5. a) Derive an expression for the hydraulic efficiency when a liquid jet strikes a single moving curved vane. (8M)
   b) A jet of water 75 mm diameter strikes a curved plate at its center with a velocity of 20m/sec. The curved plate is moving with a velocity of 8m/sec in the direction of the jet. The jet is deflected through an angle of 165^0. Assuming the plate to be smooth, find the force exerted on the plate in the direction of the jet, power of the jet and efficiency (8M)

6. a) What do you mean by manometric efficiency, mechanical efficiency and overall efficiency of a centrifugal pump? (8M)
   b) The diameter of an impeller of a centrifugal pump at inlet and outlet are 300 mm and 600 mm respectively. The velocity of flow at outlet is 2.5 m/s and vanes are set back at an angle of 45^0 at outlet. Determine the minimum starting speed of the pump if the Manometric efficiency is 75%. (8M)

7. a) What are the uses of a draft tube. Describe with neat sketches, different types of draft tubes. (8M)
   b) A Kaplan turbine working under a head of 15 m develops 7357.5 kW shaft power. The outer diameter of the runner is 4 m and hub diameter 2 m. The guide blade angle at the extreme edge of the runner is 30°. The hydraulic and overall efficiencies of the turbine are 90% and 85% respectively. If the velocity of whirl is zero at outlet, determine: (i) runner vane angles at inlet and outlet at the extreme edge of the runner and (ii) speed of the turbine. (8M)

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PART –A

1. a) Write a note on classification of manometers. (4M)
   b) Distinguish between stream function and velocity potential function. (4M)
   c) Distinguish between stream lined body and bluff body. (4M)
   d) Draw inlet and outlet velocity triangles for any specific case and explain it. (4M)
   e) Explain what an indicator diagram is. (3M)
   f) Describe the working principle of hydraulic lift. (3M)

PART -B

2. a) Differentiate between: (i) Liquids and gases, (ii) Real fluid and ideal fluids, (iii) Specific weight and specific volume of a fluid. (8M)
   b) Determine the intensity of shear of an oil having viscosity = 1.2 poise and is used for lubrication in the clearance between a 10 cm diameter shaft and its journal bearing. The clearance is 1.0 mm and shaft rotates at 200 r.p.m (8M)

3. a) Derive an expression for head loss due to friction. (8M)
   b) The water is flowing through a pipe having diameters 20 cm and 15 cm at sections 1 and 2 respectively. The rate of flow through pipe is 40 litres/s. The section 1 is 6 m above datum line and section 2 is 3 m above the datum. If the pressure at section 1 is 29.43 N/cm^2, find the intensity of pressure at section 2. (8M)

4. a) Define physically and mathematically the concept of displacement, momentum and energy thickness of a boundary layer. (8M)
   b) What do you mean by dimensionless number? What is its significance in the flow analysis? (8M)

5. a) Derive an expression for the force exerted by a jet of water striking normally a moving vertical plate. (8M)
   b) A jet of water of diameter 50 mm having a velocity of 20m/sec strikes a curved vane which is moving with a velocity of 10m/sec in the direction of the jet. The jet leaves the vane at an angle of 60^0 to the direction of motion of the vane at outlet. Determine. (8M)
   (i) The force exerted by the jet on the vane in the direction of motion and
   (ii) Work done per second by the jet.
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6. a) Define the terms: suction head, delivery head, static head and manometric head. (8M)
   b) Find the rise in pressure in the impeller of a centrifugal pump through which water is flowing at the rate of 15 litre/s. The internal and external diameters of the impeller are 20 cm and 40 cm respectively. The widths of impeller at inlet and outlet are 1.6 cm and 0.8 cm. The pump is running at 1200 r.p.m.The water enters the impeller radially at inlet and impeller vane angle at outlet is 30^0 . Neglect losses through the impeller. (8M)

7. a) Differentiate between: (i) The impulse and reaction turbines, (ii) Radial and axial flow turbines, (iii) Inward and outward radial flow turbines, and (iv) Kaplan and propeller turbines. (8M)
   b) A Pelton wheel is having a mean bucket diameter of 0.8 m and is running at 1000 r.p.m. The net head on the Pelton wheel is 400 m. If the side clearance angle is 15° and discharge through nozzle is 150 litres/s, find :
   (i) Power available at the nozzle, and (ii) Hydraulic efficiency of the turbine. (8M)