

Code.No: A109211901

R09

SET-1

II B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
FLUID MECHANICS AND HYDRAULIC MACHINERY
(ELECTRICAL AND ELECTRONICS ENGINEERING)

Time: 3hours

Max.Marks:75

Answer any FIVE questions
All questions carry equal marks

- - -

- 1.a) Distinguish between U-tube differential manometers and inverted U-tube differential manometers. Discuss their applications.
- b) Two large fixed parallel plates are 12mm apart. The space between the surfaces is filled with oil of viscosity 0.972 N.s/m^2 . A flat plate 0.25 m^2 area moves through the oil at a velocity of 0.3 m/s . Calculate the force
 - i) When the thin plate is equidistant from both the plates.
 - ii) When the thin plate is at a distant of 4mm from one of the plane surfaces.

[7+8]
- 2.a) How is the continuity equation based on the principle of conservation of mass stated? Derive the continuity equation in Cartesian coordinates for one-dimensional flow.
- b) Derive the expression for Bernulli's theorem for steady incompressible fluid from first principle. What are the limitations of the Bernoulli's equation? [7+8]
- 3.a) Explain what do you understand by Hydraulic Grade Line and Total Energy Line. Discuss its practical significance in analysis of fluid flow problems.
- b) Two pipes each 300 m long are available for connecting to a reservoir from which a flow of $0.085 \text{ m}^3/\text{s}$ is required. If the diameters of the two pipes are 300mm and 150mm respectively. Determine the ratio of head lost when the pipes are connected in series to the head lost when they are connected in parallel. Neglect minor losses. [7+8]
4. A jet of water having a velocity of 35 m/s impinges on a series of vanes moving with a velocity of 20 m/s . The jet makes an angle of 30° to the direction of motion of vanes when entering and leaves at an angle of 120° . Draw the velocity triangles at inlet and outlet and find
 - i) The angles of vanes tip so that water enters and leaves without shock.
 - ii) The work done for N of water entering the vanes and
 - iii) The efficiency. [15]
- 5.a) What are the different types of hydropower plants? Describe each one briefly?
- b) What is a mass curve? Explain the procedure for preparing a mass curve and also its uses. [7+8]

6. Design a Francis turbine for the given data; Gross head available is 100m; Losses in the penstocks is 14% of gross head; Speed of the turbine is 750 rpm; Output power developed is 450kw; hydraulic efficiency is 96% and overall efficiency is 85%. Assume 5% of the circumferential area of the runner is occupied by the thickness of vanes. The velocity of flow remains constant throughout. Assume any missing data suitably. [15]
- 7.a) What do you mean by Unit quantities and specific quantities? Explain the 'Specific Speed' of a turbine and deduce the expression for the same.
b) What are the characteristic curves of a hydraulic turbine? How are they useful to Practical Engineer? [8+7]
- 8.a) What is the role of volute and vortex chamber in a centrifugal pump.
b) What are the operating characteristic curves of a centrifugal pump? Explain them.
c) When are centrifugal pumps coupled in parallel? Sketch and explain. [5+5+5]

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- 1.a) Classify the fluids, giving examples, according to the nature of variation of viscosity.
- b) Differentiate between Absolute pressure, gauge pressure and atmospheric pressure. Explain the relationship between them with neat sketch.
- c) The dynamic viscosity of oil, used for lubrication between a shaft and sleeve is 0.6 N-s/m^2 . The shaft is of diameter 400 mm and rotates at 190 r p m. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the oil film is 1.5 mm. [5+5+5]

- 2.a) Explain the terms
 - i) Path line ii) Streak line
 - iii) Stream line and iv) Stream tube.
- b) Distinguish between
 - i) Steady and unsteady flow ii) Uniform and Non-uniform flow
 - iii) Rotational and Irrotational flow.
- c) What are the various forces that may influence the motion of fluid? [5+6+4]

- 3.a) What is “turbulence”? Derive an expression for loss of head due to friction in a pipe flow.
- b) A venturimeter of 300 mm inlet diameter and 150 mm throat diameter is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow being upward. The difference in elevation of a throat section and entrance section of the venturimeter is 300 mm. The differential mercury manometer shows a gauge deflection of 250 mm. Calculate
 - i) The discharge of oil
 - ii) The pressure difference between the entrance section and throat section.
 The coefficient of the meter is 0.98. [8+7]

- 4.a) Derive an expression for work done per second in the case of a radial curved vane.
- b) A jet of water of diameter 50 mm moving with a velocity of 20 m/s strikes a fixed plate in such a way that the angle between the jet and the plate is 60° . Find the force exerted by the jet on the plate
 - i) in the direction normal to the plate
 - ii) in the direction of the plate. [8+7]

- 5.a) What are the different types of hydropower plants? Describe each one briefly?
- b) Explain various components of hydro power plants. [8+7]

- 6.a) What is a draft tube? What are the functions of a draft tube?
- b) Calculate the diameter and speed of the runner of a Kaplan turbine developing 6000 kW under an effective head of 50 m. Overall efficiency of the turbine is 90%. The diameter of the boss is 0.4 times the external diameter of the runner. The speed ratio is 2 and flow ratio is 0.6. What is the specific speed of the turbine? [5+10]
- 7.a) Define unit speed, unit power and specific speed as used in connection with the operation of a hydraulic machine.
- b) A hydraulic turbine is to develop 845.6 kW power when running at 100 r p m under a head of 10 m. Work out the maximum flow rate and specific speed for the turbine if the overall efficiency at the best operating point is 92%. In order to predict its performance, a 1:10 scale model is tested under a head of 6 m. what would be the speed, power, output and water consumption of the model if it runs under the similar conditions to the prototype? [5+10]
- 8.a) What do you mean by 'priming'? Derive an expression for the specific speed of a centrifugal pump.
- b) Find the number of pumps required to lift water from a deep well under a total head of 89 m. All the pumps are identical and are running at 800 r p m. The specific speed of each pump is given as 25 while the rated capacity of each pump is $0.16 \text{ m}^3/\text{s}$. [8+7]

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- 1.a) Define compressible and incompressible fluid. What is specific gravity? How it is related to density?
- b) Express the Pascal law and give a real-world example of it. A vacuum gauge connected to a chamber reads 24 kPa at a location where the atmospheric pressure is 92 kPa. Determine the absolute pressure in the chamber.
- c) The hydraulic lift in a car repair shop has an output diameter of 300 mm and is to lift cars up to 20kN. Determine the fluid gauge pressure that must be maintained in the reservoir. [5+5+5]

- 2.a) Define streamline, path line and streak line. And what does these lines indicate? How the streak lines differ from stream lines?
- b) A pipeline, 600 mm diameter, carrying oil (specific gravity 0.85) at the flow rate of $1.8 \text{ m}^3/\text{s}$ has a 90° bend in horizontal plane. The pressure at the entrance to the bend is 15 N/m^2 and the loss of head in the bend is 2 m of oil. Find the magnitude and direction of the force exerted by the oil on the pipe bend and show the direction of the force on the bend. [8+7]

- 3.a) What are the different types of head losses in a pipeline. Derive Darcy-Weisbach Formula for calculating loss of head due to friction in a pipe.
- b) Two sharp ended pipes of diameter 50 mm and 100 mm respectively each of length 100 m respectively, are connected in parallel between two reservoirs which have a difference of level of 10 m. if the friction factor for each pipe is 0.128, Calculate
 - i) Rate of flow for each pipe and,
 - ii) The diameter of a single pipe 100m long which would give the same discharge, if it were substituted for the original two pipes. [8+7]

- 4.a) Series of curved vanes mounted equidistantly fixed on the periphery of a wheel. For maximum efficiency of the wheel, show that the peripheral speed is one-half of the velocity of the jet.
- b) A jet of water having a velocity of 36 m/s strikes a series of radial vanes Mounted on a wheel which is rotating at 240 r p m. The jet makes an angle of 20° with the tangent to the wheel at inlet and leaves the wheel with a velocity of 6 m/s at an angle of 130° to the tangent to the wheel at outlet. Water is flowing from outward in a radial direction. Determine
 - i) Vane angle at inlet and outlet
 - ii) Work done per second per N of water, and
 - iii) Efficiency of Wheel. [7+8]

- 5.a) What are the different types of hydropower plants? Describe each one briefly?
- b) A run-off-river hydel power plant with an installed capacity of 15000 kW operates at 20% 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 15 m. Also calculate the maximum load factor of the plant when the discharge in the stream is $30 \text{ m}^3/\text{s}$. [8+7]
- 6.a) How do the losses in the draft tube effect the pressure at the runner exit. What is the efficiency of the draft tube?
- b) A turbine is to operate under a head of 30 m and a speed of 300 r p m. The discharge is $10 \text{ m}^3/\text{s}$. If the efficiency of the turbine is 90% determine
- The specific speed of the turbine
 - Power generated and
 - Type of turbine. [7+8]
- 7.a) What are the requirements of a governor in hydropower Installation?
- b) Tests were conducted on a Francis turbine of 0.8 m diameter under a head of 10 m. The turbine developed 115 kW running at 240 r p m and consuming $1.2 \text{ m}^3/\text{s}$. If the same turbine is operated under a head of 16 m predict its new speed, discharge and power. [7+8]
- 8.a) Discuss in general the important operating characteristic curves of an axial flow pump. Compare the performance characteristics of a centrifugal pup and axial flow pump.
- b) Define and derive an expression for the specific speed of pump. How does specific speed help in pump selection? [8+7]

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Time: 3hours

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Answer any FIVE questions
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- 1.a) Differentiate between
 - i) Real fluid and ideal fluid
 - ii) Newtonian fluid and non- Newtonian fluid
 - iii) Dynamic viscosity and kinematic viscosity and its units
- b) Define and classify the manometers. What are the advantages and limitations of manometers? [8+7]
- 2.a) Differentiate between rotational and irrotational flow. Derive the continuity equation for steady incompressible one-dimensional flow in Cartesian coordinates.
- b) A discharge of $0.03 \text{ m}^3/\text{s}$ of oil (specific gravity is 0.81) occurs downward through a converging pipe line held inclined at 60° to the horizontal. The inlet diameter is 200mm and the out let diameter is 150 mm and length of the pipe is 2 m. If the pressure at the top of the inlet is 0.8 kgf/cm^2 , find the pressure at the out let. Neglect the energy loss. [8+7]
- 3.a) What is Darcy's friction factor in pipe flow? On what factors does the coefficient of friction depends?
- b) What are the minor losses in pipes? Give the appropriate formulae to calculate the losses?
- c) A Pitot tube is used to measure the velocity of an airplane. A U-tube manometer connected to the Pitot tube registers a head of 90 mm of mercury. Find the speed of the plane. Assume $C = 0.98$ and $\gamma_{\text{air}} = 12.2 \text{ N/m}^3$. [4+4+7]
- 4.a) A series of flat plates mounted on a wheel intercepts a jet of diameter 60 mm and velocity 25 m/s normal to the plates successively. If the plates move at a velocity of 10 m/s what is the power developed.
- b) A plate of length 600 mm and weighing 100N is hung from the hinge at the top. It is hit by a jet of water diameter 12 mm having a velocity of 20 m/s, the jet axis being 350 mm, below the hinge. Find the angle that the plate will make with the vertical when the jet (at the same level) plays on the plate? [7+8]
- 5.a) What are the different types of hydropower plants? Explain about pumped storage plants and run-off-river plants.
- b) How do you assess the water potential of hydroelectric scheme?
- c) Write a short note on selection of suitable type of turbine for a hydroelectric scheme. [8+4+3]

- 6.a) What is a draft tube? Why it is used in a reaction turbine? Explain with neat Sketch two different types of draft tubes.
- b) Discuss the working proportions of a Pelton wheel turbine. [8+7]
- 7.a) What is significance of Unit and Specific quantities related to turbines?
- b) A Kaplan turbine is used to develop 2400 kW when running at 240 r p m under a head of 50 m. In order to predict its performance a model of scale 1:5 is tested under a net head of 25 m. At what speed should the model run and what power would it develop. Determine the discharge in the in the model and in full scale if the overall efficiency of the model is 85%. [7+8]
- 8.a) What do you understand by
- | | |
|-------------------------------------|----------------------|
| i) NPSH | ii) Priming of pump |
| iii) Minimum starting speed of pump | iv) Multistage pumps |
- b) A centrifugal pump has an impeller of 350 mm diameter. The discharge at the outlet is radial. The diameter ratio is 2. Calculate the manometric efficiency of the pump if the total lift is 25 m. Also calculate the blade angle and relative velocity at the inlet. [8+7]
