Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – WINTER 2013

Subject Code: 152003 Date: 04-12-2013

Subject Name: Fluid Mechanics and Machines

Time: 10.30 am - 01.00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Give differences between following: **07**
(1) Mass density and Weight density.
(2) Absolute Viscosity and Kinematic Viscosity.
(3) Newtonian and Non- Newtonian fluids.

(b) (1) What is vapour pressure? How can water boil at room temperature? Discuss significance of vapour pressure in problems related to liquids in motion. **04**

(2) Find the Kinematic Viscosity of a liquid in stokes whose specific gravity is 0.95 and Dynamic viscosity is 0.012 poise. **03**

Q.2 **(a)** (1) State and prove the Pascal's law. **04**

(2) Calculate the capillary effects in mm for a glass tube of 4 mm diameter, when immersed in (i) water and (ii) in mercury. The values of surface tension of water and mercury in contact with air are 0.0735 N/m and 0.48 N/m respectively. The contact angle of water =0 and for mercury =130 **03**

(b) Derive an expression for the depth of the of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid. **07**

OR

(b) A rectangular plate of 2 m length and 1 m height lies immersed vertically in a liquid of relative density 0.75 such that 2 m side is parallel to and at a depth of 0.7 m from the free liquid surface. If the plate has a circular hole of 0.5 m diameter drilled at its centre, compute the total pressure exerted by the liquid on the plate and the depth of the centre of pressure. **07**

Q.3 **(a)** (1) Derive Bernoulli's theorem for one dimensional flow. State assumptions made. **04**

(2) The velocity components in a 2D flow field for an incompressible fluid are expressed as, $u= y^3/3 + 2x-x^2y$; $v= xy^2-2y-x^3/3$. Show that it represents Irrotational flow. **03**

(b) 250 litres per second water is flowing in a pipe having diameter of 300 mm. If the pipe is bent by 135, find the magnitude and direction of resultant force on the bend. The pressure of water flowing in the pipe is 400 kPa. **07**

OR

Q.3 **(a)** (1) Derive an expression for head loss when flow is passing through sudden enlargement of pipe. **03**

(2) A pipe 5 meter long and having varying cross section, carries a discharge of on 0.005m3/s. the pipe configuration is d_1=5cm, L_1=1.5 m, d_2=7.5cm , L_2= 2m , d_3 =5cm, L_3=1.5m.the changes of section being sudden. Determine the loss of head. Take friction coefficient f= 0.01 for the pipe of both diameters and contraction loss coefficient =0.5. **04**

(b) A 300 mm diameter pipe carries water under a head of 20 m with a velocity of 3.5 m/s. If the axis of pipe turns through 45, find the magnitude and direction of the resultant force on the bend. **07**

Q.4 **(a)** Draw and explain constant head characteristics of Francis and Kaplan turbines. **07**

(b) (1) Prove that the hydraulic efficiency of Pelton wheel is maximum when u/v= 0.5. **04**

(2) A double jet Pelton wheel operates under a 40 m head and develops 735 kW power when running at 450 rpm. Calculate the flow rate and the jet diameter. Assume overall efficiency =0.85 and coefficient of velocity=0.98. **03**

OR

Q.4 **(a)** (1) Give differences between Propeller and Kaplan turbine. **03**

(2) A Kaplan turbine develops 8850 kW at the turbine at the turbine shaft. Net head available is 5.5 m, speed ratio 2.1, flow ratio 0.67 and overall efficiency 85%. Assume that the hub diameter of the runner is 0.35 times the outside diameter, find out the runner diameter and its rotational speed. **04**

(b) Explain in detail guide vane operating mechanism and runner vane operating mechanism in case of Kaplan turbine. **07**

Q.5 **(a)** Describe the shape and type of casings and Impellers for centrifugal pumps. **07**

(b) A centrifugal pump having 350 mm outlet diameter and 180mm inlet diameter is to deliver water against a net head of 25 m at the design speed of 1200 rpm. The width of impeller wheel at outlet is 60 mm and the flow velocity is constant from inlet to outlet. The entry is radial and the impeller vanes are bent backward at 30 to the tangent at outlet. Assume manometric hydraulic efficiency of 90%. Calculate the width of impeller at inlet, the angle of vane tip at inlet and the discharge of pump. **07**

OR

Q.5 **(a)** What is cavitation? What are its causes? How cavitation can be prevented in centrifugal pump. **07**

(b) (1) Define and derive Specific speed relation for pump. **03**

(2) A model power P= 30 kW, Head H= 8 m and speed N= 1000 rpm. If the prototype pump has to work against a head of 25 m, make calculations for its working speed, the power required to drive it and the ratio of the flow rates handled by the two pumps. Model to prototype scale ratio is 1/5. **04**

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