Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEMESTER IV– • EXAMINATION – SUMMER 2015

Subject Code: 143403 **Date: 03/06/2015**

Subject Name: Fluid Mechanics and Machinery

Time: 10.30am-01.00pm **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)** Define the terms: Density, Adhesion, Absolute pressure, Capillarity. **07**

If the pressure of liquid increases by 0.65 MPa, there is 0.02% increase in its density. Calculate the bulk modulus of the liquid.

(b) State and explain: Momentum principle. What are its applications? Why are the buckets of the impulse turbine designed of hemispherical shape? **07**

Q.2 **(a)** State Bernoulli's theorem. What are the assumptions in it? **07**

A pipe carrying water changes in size from 20 cm dia. at point *A* to 30 cm dia. at point *B*, point *B* being at 3 m higher level than point *A*. If the pressures at *A* and *B* is 100 kPa and 60 kPa respectively and the discharge through the pipe is 0.25 m^3/s, determine the head loss and the direction of flow.

(b) Differentiate between dynamic viscosity and kinematic viscosity **07**

The clearance between a 75 mm dia. shaft and its journal bearing is 0.8 mm. The speed of the shaft is 120 rpm. Calculate the shear stress induced in the lubricant in contact with surface of the shaft. Take dynamic viscosity of the lubricating fluid $\mu = 0.1$ Pa-s.

OR

(b) Explain 'Newton's law of viscosity' and differentiate between Newtonian fluid and non-newtonian fluid. **07**

A flat plate of area 1.5 m^2 is pulled at a speed of 0.4 m/s relative to another fixed plate located at a distance of 0.15 mm from it. Find the force and power required to maintain this speed if the fluid separating them is having viscosity 1 poise.

Q.3 **(a)** Discuss the characteristics of 'Laminar flow'. **07**

A laminar flow takes place in a pipe of 300 mm diameter. The maximum velocity is 0.2 m/s. Calculate the average velocity and radius at which this occurs. Also, calculate the velocity at 45 mm from the pipe axis. Take dynamic viscosity $\mu = 0.1$ N-s/m^2.

(b) Discuss the different types of losses that occur when flow takes place through pipes? What are the causes its occurrence? Derive the equation for the head loss due to sudden enlargement. **07**

OR

Q.3 **(a)** Discuss: Pipes in parallel. **07**

Two reservoirs are connected by a 25 cm dia. pipe, 3 km long. The difference in water levels of the reservoirs is 15 m. Find the discharge to the lower level reservoir. If a 25 cm dia. additional pipe is attached parallel to the last 1.5 km length of the existing pipe, calculate the increase in the discharge. Neglect minor losses and take Darcy' friction factor f = 0.04.

(b) What are the advantages of model testing? Discuss the necessary conditions for the model to be dynamically similar to its prototype? **07**

Q.4 **(a)** (i) Distinguish between 'Reaction turbine' and 'Impulse turbine' with suitable examples. **02**

(ii) Explain: Cavitation. What are its effects? How can it be avoided in the turbines? **05**

(b) Using Buckingham's π-theorem, show that the resistance (F) to the motion of a sphere of diameter (D) moving with a uniform velocity (V) through a real fluid of density (ρ) and viscosity (μ) is given by: **07**

$$F = \rho D^2 V^2 . \Phi\left(\frac{\mu}{\rho V D}\right)$$

OR

Q.4 **(a)** An inward flow reaction turbine running at 500 rpm has an external dia. of 70 cm and a width of 18 cm. If the guide vanes are at 20˚ to the wheel tangent and the absolute velocity of water at inlet is 25 m/s, calculate the discharge and runner vane angle at inlet. **07**

(b) Explain the following terms in view of the centrifugal pump: **07**

(i) Priming (iii) Multistage pump

(ii) Manometric efficiency (iv) Specific speed

Q.5 **(a)** Explain 'Positive displacement pump'. With a neat diagram, discuss the working of a single acting reciprocating pump. **07**

A single acting reciprocating pump having a bore dia. 15 cm and a 30 cm stroke raises water from a sump. If the pump runs at 40 rpm and it delivers 210 lit/min, calculate the theoretical average discharge and percentage slip.

(b) Explain, with a neat sketch, working of a single stage centrifugal pump. Also, discuss the role of volute chamber in the centrifugal pump. **07**

OR

Q.5 **(a)** Explain the terms: (i) Boundary layer thickness (ii) Displacement thickness **07**

The velocity distribution in the boundary layer is given as, $\frac{u}{U} = (\frac{y}{\delta})$,

where 'u' is the point velocity at distance 'y' from the boundary, 'δ' is the boundary layer thickness and 'U' is the free stream flow velocity. Compute the displacement thickness and momentum thickness, if the boundary layer thickness is 6 mm.

(b) What are the shortcomings of ordinary reciprocating pumps? How is it possible to overcome them using air vessels with the single acting reciprocating pump? **07**

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