B 2106

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Third Semester

Mechanical Engineering

CE 253 — FLUID MECHANICS AND MACHINERY

(Common to Mechatronics Engineering)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between kinematic and dynamic viscosity.

2. State Newton's law of viscosity.

3. State the general continuity equation for a 3-D, incompressible fluid flow.

4. State the usefulness of 'momentum equation' as applicable to fluid flow phenomenon.

5. What are 'major' and 'minor losses' of flow through pipes?

6. Distinguish between : Hydraulic Gradient Line (HGL) and Total Energy Line (TEL).

7. State a few applications/usefulness of 'dimensional analysis'.

8. Define : (a) Euler number and (b) Mach number.

9. Differentiate between pumps and turbines.

10. Define indicator diagram. State its uses.

PART B — (5 × 16 = 80 marks)

11. (a) (i) State the assumptions in the derivation of Bernoulli's equation. (4)

(ii) Gasoline (sp.gr. = 0.8) is flowing upwards through a vertical pipe line which tapers from 300 mm to 150 mm diameter. A gasoline mercury differential manometer is connected between 300 mm and 150 mm pipe sections to measure the rate of flow. The distance between the manometer tappings is 1 metre and the gauge reading is 500 mm of mercury. Find (1) differential gauge reading interms of gasoline head (2) rate of flow. Assume frictional and other losses are negligible. (12)

Or

(b) (i) State Euler's equation of motion, in the differential form. Derive Bernoulli's equation from the above for the case of an 'ideal fluid flow'. (4)

(ii) Water enters a reducing pipe horizontally and comes out vertically in the downward direction. If the inlet velocity is 5 m/s and presure is 80 kPa (gauge) and the diameters at the entrance and exit sections are 30 cm and 20 cm respty, calculate the components of the reaction acting on the pipe. (12)

12. (a) (i) For flow of viscous fluids through an annulus derive the following expressions : (1) discharge through the annulus and (2) shear stress distribution. (12)

(ii) Define momentum thickness and energy thickness. (4)

Or

(b) Two pipes of diameter 400 mm and 200 mm are each 300 m long. Where the pipes are connected in series the discharge through the pipe line is 0.10 m^3/s. Find the loss of head. What would the loss of head in the system to pass the same total discharge when the pipes are connected in parallel? Assume Darcy's friction factor as 0.0075. (16)

13. (a) (i) What are 'repeating variables'? How are these selected? (3)

(ii) What is meant by geometric, kinematic and dynamic similarities? (3)

(iii) In an aeroplane model of size $\left(\frac{1}{10}\right)$ of its prototype, the pressure drop is 7.5 kN/m^2. The model is tested in water. Find the corresponding drop in the prototype. Assume : density of air = 1.24 kg/m^3 ; density of water = 1000 kg/m^3 ; viscosity of air = 0.00018 poise ; viscosity of water = 0.01 poise. (10)

Or

(b) (i) Define surface tension and compressibility of a fluid. (4)

(ii) Define 'vapour pressure'. How does it vary with temperature? (2)

(iii) A vertical cylinder of diameter 180 mm rotates concentrically inside another cylinder of diameter 181.2 mm. Both the cylinders are 300 mm high. The space between the two cylinders is filled with a liquid whose viscosity is unknown. Determine the viscosity of the fluid if the torque of 20 N-m is required to rotate the inner cylinder @ 120 rpm. (10)

14. (a) (i) Define overall efficiency and plant efficiency of turbines. (2)

(ii) What is a 'breaking jet' in a Pelton wheel/turbine? (2)

(iii) A single jet Pelton wheel runs at 300 rpm under a head of 510 m. The jet diameter is 200 mm and its deflection inside the bucket is 165°. Assuming that its relative velocity is reduced by 15% due to friction, determine : (1) water power (2) resultant force on bucket and (3) overall efficiency. (12)

Or

(b) (i) Define speed of a centrifugal pump. How does it differ from that of a turbine. (4)

(ii) The impeller of a centrifugal pump is 300 mm in diameter and having a width of 50 mm at the pheriphery. It has blades whose tip angles are inclined backwards at 60° from the radius. The pump delivers 17 m^3/min. of water and the impeller rotates at 1000 rpm. Assuming that the pump is designed to admit liquid radically, calculate : (1) speed and direction of water as it leaves impeller (2) torque exerted by the impeller on water (3) shaft power required (4) lift of the pump. Assume the mechanical efficiency = 95% and the hydraulic efficiency = 75%. (12)

15. (a) (i) Define percentage step and indicator diagram, with respect to a reciprocating pump. (2 × 2 = 4)

(ii) The diameter and stroke length of a single-acting reciprocating pump are 75 mm and 150 mm respectively. Supply of water to the pump is from a sump 3 m below the pump through a pipe 5 m long and 40 mm in diameter. The pump delivers the water to a tank located at 12 m above the pump through a pipe 30 mm in diameter and 15 m long. Assuming that separation of flow occurs at 75 kN/m^2 (below the atmospheric pressure), find the maximum speed at which the pump may be operated without any separation. Assume that the piston executes a simple harmonic motion. (12)

Or

(b) (i) What is an air vessel? What are the uses/advantages of fitting air vessels in a reciprocating pump? (4)

(ii) A double-acting reciprocating pump is running at 30 rpm. Its bore and stroke are 250 mm and 400 mm respectively. The pump lifts water from a sump 3.8 m below and delivers it to a tank located at 65 m above the axis of the pump. The length of suction and delivery pipes are 6 m and 150 m respectively. The diameter of the delivery pipe is 100 mm. If an air vessel of adequate capacity has been fitted on the delivery side of the pump, determine : (1) the minimum diameter of the suction pipe to prevent separation of flow, assuming the minimum head to prevent occurrance of separation is 2.5 m, (2) the maximum gross head against which the pump has to work and the corresponding power of motor. Assume the mechanical efficiency = 78% and slip = 1.5 % ; H atm = 10.0 m ; F = 0.012. (12)
