B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2006.

Fourth Semester

Civil Engineering

CE 238 — APPLIED HYDRAULIC ENGINEERING

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1.   Define the term open channel flow.

2.   In an open channel where the energy line will occur?

3.   Write the dimensions of Chezy's constant C.

4.   Which is called as hydraulically efficiency channel cross-section.

5.   In a open channel of great width, which is hydraulic radius?

6.   Which is called as the critical depth?

7.   What torque is required to give 3 m³/s water a moment of momentum so that it has a tangential velocity of 3 m/s at a distance of 2 m from the axis?

8.   A reaction-type turbine discharges 34 m³/s under a head of 7.5 m and with an overall efficiency of 91 percent. What is the power developed?

9.   When will you choose a reciprocating pump?

10. Which type of pump is chosen to deliver highly viscous fluid at low heads?

PART B — (5 × 16 = 80 marks)

11. (i)   Derive the Chezy's equation for uniform flow in a channel.   (8)

     (ii) A trapezoidal channel with base width 3 m and side slope 2H : 1V carries a discharge of 10 m³/s at a depth of 1.5 m under uniform flow condition. The longitudinal slope of the channel is 0.001. Compute the average shear stress in N/m² on the boundary and also compute the Manning's n value.   (8)

12. (a) (i) Derive the condition for hydraulically efficient trapezoidal channel. (8)

(ii) Determine the dimensions of the most economical trapezoidal channel with Manning's $n = 0.02$, to carry a discharge of 14 m^3/s at a slope of 4 in 10,000. (8)

Or

(b) (i) Find the critical depth and minimum specific energy for a discharge of 2.5 m^3/s per meter width of the channel. (6)

(ii) An open channel of trapezoidal section, 2.5 m at the base and having sides inclined at 60° to the horizontal. It is found that when the flow is 1.5 m^3/s the depth of water in the channel is 0.5 m. Assuming the validity of the Manning's formula, calculate the flow when the depth is 0.7 m. (10)

13. (a) A rectangular channel with Manning's $n = 0.015$ is 2 m wide and has a bottom slope of 1 in 1600. If it ends in a free outfall, how far from the outfall is the depth 0.80 m when the flow rate is 2 m^3/s? (Use direct-step method). (16)

Or

(b) (i) Derive the Belanger's equation for sequent depths of a hydraulic jump in a horizontal rectangular channel. (8)

(ii) With discharge intensity of 10 $m^3/s/m$ and initial Froude number of 4, determine the initial velocity, initial depth, sequent depth and energy loss in a rectangular channel. (8)

14. (a) (i) Derive an expression for the Euler's Head developed by a rotodynamic hydraulic machine. (8)

(ii) The impeller of a centrifugal pump has a diameter of 0.1 m and width at the outlet of the impeller is 15 mm. The blades are swept backwards and inclined at 25° to the tangent to the periphery. The flow rate is 8.5 $m^3/hour$ and rotates at 750 r.p.m. Calculate the head of water developed. Assume radial inflow. (8)

Or

(b) An inward flow turbine has outside diameter of 1 m and inside diameter of 0.5 m. The supply jet is at 30° to the tangent to the outside circle with a velocity of 40 m/s. The water is to leave the wheel at 3.5m/s at 120° to the tangent to the inner circle. Draw the velocity triangles for the inlet and the outlet and find suitable blade angles if the wheel runs at 360 r.p.m. (16)

(a) The outlet of impeller of a centrifugal pump is placed at a height of 4 m above the water in the sump. The suction pipe is 15 cm in diameter and the discharge is 1800 lit/min. The total head through which water is lifted 25 m. The blades are curved back and make an angle 30° with the tangent at the outlet tip of the wheel. The radial velocity of flow at exit is 3 m/s and the pump efficiency is 70 percent. Determine (i) the pump speed if the impeller diameter is 50 cm; (ii) the pressure at inlet and outlet of the wheel. Assume that the energy loss takes place after the water leaves the wheel, and that the entry is radial. (16)

Or

(b) A single-acting reciprocating pump, having a bore and stroke of 200 mm and 400 mm, respectively, runs at 20 rev/min. The suction pipe, which has a diameter of 100 mm and a length of 9.1 m, has no air chamber fitted. The suction lift is 3.6 m. The discharge pipe is also 100 mm bore and is 470 m long, the discharge being 15.2 m above the pump level, and is fitted with an air chamber 15 from the pump. Assuming simple harmonic motion for the piston motion and taking friction factor as 0.04 for all pipes, calculate the cylinder pressure at the start, middle and end of both suction and discharge strokes. Take atmospheric pressure as 10.34 m of water. (16)