M.E. (Water Resources & Hydraulic Engineering) Examination, 2024

(1st Semester)

HYDRAULICS & SEDIMENT TRANSPORT

(Paper - III)

Time : Three Hours | Full Marks : 100

Answer any ***five*** questions.

1. a) What do you mean by sediment?
   b) Define (i) volume constant, (ii) surface constant, (iii) sphericity, (iv) flatness ratio and (v) fall velocity.
   c) What are the assumptions made in the derivation of Stokes' law?
   Derive the Stokes' law for the terminal fall velocity of a spherical sedimentary particle. Then find out the Stokes' number.

   2+10+8 = 20

2. a) Derive the tangential and normal acceleration components in case of 1-D flow along a streamline, consider a fluid particle undergoing a small displacement *ds* in a short interval of time *dt*
   b) Derive the Navier-Stokes Equations of Motion for a Newtonian Fluid of varying density and viscosity in a gravitational field.

   8+12= 20

3. a) Find out the logarithmic law in the turbulent layer.
   b) Deduce the relationship between total shear stress and bed shear stress for a steady flow having zero pressure gradient in the *x*-direction (with stream wise slope θ). Assume the flow is uniform.
   c) Define kinematic Eddy viscosity and explain the Boussinesq equation.

   6+9+5= 20

4. a) A sample of 2.95×10^{-3} m^3 of river water is evaporated to collect suspended sediment of 5.2 N (dry weight), having d_{50} = 0.15 mm and s = 2.65. Determine (i) sediment concentration by volume (C), (ii) sediment concentration by mass (c), (iii) mass density of fluid sediment mixture (ρ_m), (iv) specific weight of water sediment mixture (γ_m), and (v) kinematic viscosity of water sediment mixture (ν_m). Consider dynamic viscosity for a clear water (μ) as 10^{-3} Pa s.
   b) In case of a fluid flow over a solid boundary classify different flow layers like laminar sub layer, buffer layer, turbulent logarithmic layer and turbulent outer layer using a suitable sketch.

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Then show the depth wise variation of turbulent shear stress and viscous shear stress with respect to total shear stress. Also, draw the velocity profiles of different layers.

c) What do you mean by incipient motion and sediment threshold/critical condition?

8+8+4=20

5. a) Water flows at a depth of 0.8 m in a 10 m wide stream having a bed slope of 1 in 2500. The median diameter of the sand bed is 3 mm. Determine whether the soil particles are stationary or moving, and comment as to whether the stream bed is scouring or non-scouring. Assume the specific gravity of the sand bed is 2.60.

   b) Draw a diagram to show the directions of three normal stresses in (x, y, z) directions and six shear stresses.

   c) What are dunes, antidunes, and ripples?

8+6+6=20

6. a) What do you mean by the terms "chute" and "pool"?

   b) What is meant by the "No slip" condition?

   c) Derive the Reynolds' Averaged Navier Stokes Equations (RANSE) for an incompressible fluid flow in the Cartesian coordinate system.

2+2+16=20

7. a) Define steady, non-steady, uniform and non-uniform flow.

   b) What is Bridge Scour? What are the three types of scour that affect bridges?

   c) What are clear water scour and live bed scour? Explain with figure the time to reach equilibrium scour condition for clear water scour and live bed scour.

   d) What is Froude number and Densimetric Froude number?

   e) What is a block ramp? Explain why block ramps are preferred over check dams in mountainous rivers.

2+4+6+5+3= 20