M.E. (Water Resources & Hydraulic Engg.) Examination (6 Semester), 2018

(2^{nd} Semester)

HYDRAULICS & SEDIMENT TRANSPORT

(Paper - III)

Time : Three Hours Full Marks : 100

Answer any ***five*** questions.

1. a) Name major properties of individual sedimentary particles in which hydraulic engineers are interested?
   b) Define (i) tri-axial size, (ii) Markwick's constant, (iii) shape factor, (iv) sphericity, (v) angle of repose and (vi) no slip condition
   c) Give the grade scale for size terms for sedimentary particles.

   3+12+5= 20

2. a) Define (i) volume constant, (ii) surface constant, (iii) Andreasen's coefficient (iv) roundness, (v) flatness ratio and (vi) fall velocity.
   b) What are the assumptions made in the derivation of Stokes' Law? Derive the Stokes' Law for the terminal fall velocity of a sphere and find out the Stokes' Number?

   12+8 = 20

3. a) Derive the Euler's equation of motion. Show that the integration of Euler's equation yields Bernoulli's equation.
   b) Derive the Navier-Stokes Equations of Motion for a Newtonian Fluid of varying density and viscosity in a gravitational field.

   10+10 = 20

4. a) 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 suitable sketch.

      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.
   b) Differentiate between hydraulically smooth flow, transitional flow and rough flow
   c) Find out the linear law in viscous sub layer.

   10+4+6 = 20

5. a) Define bed roughness.
   b) Derive the Reynolds' Averaged Navier Stokes Equations (RANSE) for an incompressible fluid flow in the Cartesian coordinate system.

2+18=20

6. a) Discuss on the effect of pier width relative to sediment size on scour depth.
   b) What are the main characteristics of Block Ramp? Explain hydraulics of a Block Ramp?
   c) Explain how the formation of a ridge (dune) in stilling basin influences the formation of hydraulic jump and scour formation downstream of block ramp.
   d) Write down the expression to evaluate the scour depth (Z_m) downstream of a block ramp in case of all kinds (uniform and non uniform) of stilling basin material. Give the range of validity of these equations.

(5)+(3+4)+4+4= 20

e) a) What is a block ramp? Explain why block ramps are preferred over check dams in mountainous rivers.
   b) What is clear water scour and live bed scour? At what condition equilibrium scour condition is reached during clear water scour and live bed scour?
   c) Draw the graph showing the range of hydraulic jumps downstream of a block ramp with respect to slope and densimetric Froude number. Explain the different regions of this graph.
   d) What is the difference between Froude number and Densimetric Froude number?

4+5+(4+4)+3= 20

f) a) Why the scour depth is more in case of uniform bed material compared to non uniform bed material.
   b) Consider a block ramp is constructed in a flume in a laboratory. The width of the flume is 35 cm and depth of flow at the toe of the ramp h_1= 3.1 cm and discharge Q=16 lt/sec and the stilling basin material d_{50}=0.32 cm. Considering the density of material as ρ_s=2537 kg/m^3. Find out the densimetric Froude number (F_{d50}).
   c) Considering a block ramp with slope (S) 0.166, draw a graph of scour depth vs F_{d50} with s (s = 1.2 and 2.8) as parameter and explain (take F_{d50} value within 1 to 5) . Draw the same graph taking F_{d90} instead of F_{d50} and explain. (Use graph paper).

   Explain why the change of trend in case of scour depth with increasing s (uniformity parameter) differs in case of F_{d50} and F_{d90}.

3+3+(6+6+2)= 20