B.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2018

FLUID MECHANICS- I

Time: Three hours (*Answer any FIVE questions*) Marks: 100

Different parts of the same question should be answered together.
All symbols carry their usual meanings unless otherwise mentioned.
Assume any relevant data if necessary.

1. a) What is viscosity? State and explain the Newton's Law of viscosity. 6
   b) Classify different type of non-Newtonian fluids with examples. 4
   c) A shaft having a diameter of 60 mm rotates centrally in a journal bearing having a diameter of 60.1 mm and length 120 mm. The annular space between the shaft and the bearing is filled with oil having viscosity of 1 poise. Determine the power absorbed in the bearing when the speed of rotation is 150 rpm. 10
2. a) State and prove the Hydrostatic Law. 6
   b) How manometers are classified. 6
   c) An inverted differential manometer containing an oil of sp. gravity 0.4 is connected to find the difference of pressure at two points of pipe containing water. If the manometer reading is 50 cm, find the difference of pressure. 8
3. a) What is centre of pressure? Derive an expression for force exerted by static fluid on a vertical plane surface and locate the centre of pressure. 12
   b) A circular plate 3 m diameter is submerged in water. Its greatest and least depths from the free surface are 2 m and 1 m respectively. Find the total pressure on front surface of the plate and the position of centre of pressure. 8
4. a) Define uniform and unsteady flow with example. 4
   b) Derive an expression for continuity equation for a three-dimensional fluid flow. 8
   c) A two-dimensional flow field is given by $\mathbf{V} = 2x^3\mathbf{i} - 6x^2y\mathbf{j}$. Is this flow physically possible? Check whether the flow is rotational or irrotational. If rotational, determine the angular velocity, vorticity, shear and linear strain rates. Also find the circulation about the circle $x^2 + y^2 - 2ay = 0$. 8
5. a) Define streamline, pathline and streakline. 6
   b) A flow is described by the stream function $\psi = 2\sqrt{3}xy$. Locate the point at which the velocity vector has a magnitude of 4 units and makes and angle of 150^0 with the x-axis. 7

c) The velocity of water at the outer edge of a whirlpool where the water level is horizontal and in the same plane as the bulk of the liquid, is 2m/s and the diameter is 500mm. Calculate the depth of the free surface at a diameter of 100mm from the eye of the whirlpool. 7

6. a) Stating all the necessary assumptions, derive Bernoulli's equation. 8

b) A horizontal pipe of 100*mm* diameter connects a reservoir containing oil of relative density 0.8 and a nozzle whose exit diameter is 25*mm*. The free surface of oil in the reservoir is 4*m* above the axes of the pipe and the nozzle. Assuming the total head loss as $20V^2/(2g)$, V and g being the average flow velocity in the pipe and acceleration due to gravity respectively, find the discharge and the pressure at the nozzle base, where its diameter is 100*mm*. 8

c) Calculate the Reynolds number for a fluid of density 900 kg/m^3 and dynamic viscosity 0.038 Pa s flowing in a 50 mm diameter pipe at the rate of 2.5L/s. Estimate the mean velocity above which laminar flow would be unlikely. 4

7. Write short notes on (any **FOUR**): 20

a) Stability of floating body

b) Velocity potential function and stream function.

c) Laminar and turbulent flow

d) Pressure variation normal to streamlines

e) Forced vortex flow