Total No. of Questions: 09

B.Tech. (CE) (2011 Onwards) (Sem. – 3)

FLUID MECHANICS-I

M Code: 56072

Subject Code: BTCE-301

Paper ID: [A1113]

Time: 3 Hrs. **Max. Marks: 60**

INSTRUCTIONS TO CANDIDATES:

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION A

1. a) Explain Newton's law of viscosity.

   b) What do you understand by the term cavitation and what is its significance?

   c) Derive an expression for depth of centre of pressure on a vertical surface immersed in a liquid.

   d) What is a streamline and what are the characteristics of stream lines?

   e) What is Reynolds number and what is its significance?

   f) State Bernoulli's theorem. What are its limitations?

   g) Differentiate free and forced vortex motions. Give examples.

   h) Define the terms dimensional analysis and model analysis.

   i) How are the drag and lift forces caused on a body immersed in a moving fluid?

   j) Derive an expression for discharge over a sharp crested rectangular weir.

SECTION B

2. A cylinder contains a liquid of volume 0.135 m^3 at a pressure of 750 Pa, when the liquid is compressed to a volume of 0.0134 m^3, the pressure is increased to 1400 Pa. Find the bulk modulus of elasticity of the liquid.

3. The left limb of a U-tube mercury manometer is connected to a pipe line conveying water, the level of mercury in the left limb being 0.6 m below the centre of pipe line and the right limb is open to atmosphere. The level of mercury in the right limb is 0.45 m above that in the left limb and the space above mercury in the right limb contains Benzene (Specific gravity 0.88) to a height of 0.3 m. Find pressure in the pipe line.

4. The velocity components of a 3D incompressible fluid flow are given as: $u = (x^2 + y^2 + z^2)$ and $v = -(xy + yz + zx)$. Find the third component of velocity that satisfies the continuity. Does potential function and stream function exist for such a flow?

5. A tapering pipe has a diameter of 250 mm at section 1 and a diameter of 350 mm at section 2. The distance between the two sections is 5 m and the flow is from section 1 to section 2. If pressure at section 1 is 120 kPa; calculate the pressure at section 2 for a discharge of 0.20 m^3/s of water. The kinetic energy correction factors for sections 1 and 2 are 1.1 and 1.5, respectively. The loss of head through the pipe can be assumed as $[1.2(V_1 - V_2)^2/2g]$, V_1 and V_2 are the mean velocities of flow at sections 1 and 2, respectively.

6. A ship has vertical rotors, 2.5 m in diameter and 8 m high. Due to spinning of the rotors at 240 rpm, the relative motion of air to the ship results in 50 kmph of wind. Calculate the lift force exerted on the ship by the spinning rotors. Take density of air = 1.24 kg/m^3.

SECTION C

7. A rectangular pontoon 12 m x 9 m x 3 m weighs 1380 kN and is floating in sea water of specific weight, 10 kN/m^3. A boiler 6 m diameter and weighing 864 kN is placed on the upper deck of pontoon. The center of gravity of boiler and the pontoon may be assumed at their geometrical centres and on the same vertical line. Determine the metacentric height and comment on the stability of the system.

8. Using Buckingham's method of dimensional analysis, derive an expression for frictional torque T acting on a disc of diameter D, rotating at a speed N in a fluid of dynamic viscosity μ and mass density ρ. Further using this expression, find the torque acting on a disc of 240 mm diameter rotating at 3000 rpm in air having ρ = 1.24 kg/m^3 and μ = 0.0181 cP, if a similar disc of diameter 90 mm rotates in water having ρ = 1000 kg/m^3 and μ = l cP require a torque of 0.77 Nm.

9. An inclined pipe making an angle of 30° with horizontal has a 300 mm x 150 mm venturimeter. A U-tube mercury-water differential manometer connected between inlet and throat shows a reading of 300 mm, the flow being upward. If distance between the gauge points along the length of pipe is 450 mm, determine i) discharge ii) pressure at the throat, pressure at the inlet being 50 kPa and (iii) head loss. Given, coefficient of discharge of venturimeter = 0·98.