Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

IV SEMESTER B.TECH (MECHANICAL ENGINEERING)
END SEMESTER MAKEUP EXAMINATION – JUNE 2019
SUBJECT: FLUID MECHANICS (MME 2202)
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:
- Answer ALL the questions.
- Missing data may be suitably assumed.
- Draw sketches as applicable
- Assumptions made must be clearly mentioned

1A. Define and explain the following:
(i) Surface tension
(ii) Bulk modulus 02

1B. Determine the shear stress of an oil having viscosity 10 poise. The oil is used for lubricating the clearance between a shaft of diameter 10 cm and its journal bearing. The radial clearance is 1.5 mm and the shaft rotates at 150 rpm. 02

1C. State and prove the Pascal's law. Use usual notations and symbols. 03

1D. A circular plate 3 m diameter is submerged in water such that its surface is inclined to the free surface of water. Its greatest and least depths below the free surface of water are 2 m and 1 m respectively. Draw a schematic of the arrangement and show the distribution of hydrostatic pressure on its surface. Also find:
(i) the total hydrostatic pressure force acting on its surface
(ii) the position of center of pressure 03

2A. A wooden cylinder of specific gravity 0.60 and circular in cross-section is required to float in an oil of specific gravity 0.90. Find the L/D ratio for the cylinder to float with its longitudinal axis vertical in oil, where L is the height of cylinder and D is its diameter. 03

2B. A U-tube manometer is used to measure the pressure of water in a pipe line, which is greater than the atmospheric pressure. The right limb of the manometer contains mercury and is open to atmosphere. The contact between water and mercury is in the left limb.
(i) Determine the pressure of water in the pipe, if the difference in level of mercury in the limbs of U-tube is 10 cm and the free surface of mercury is in level with the centre of the pipe.
(ii) If the pressure of water in pipe line is reduced to 9810 N/m^2, calculate the new difference in the level of mercury. 02

2C. (i) Define a stream line. Explain how to obtain the equation of stream line/s.
(ii) Explain how a flow could be considered to be incompressible even if the liquid flowing is compressible. 02

2D. Derive the continuity equation in the 3D Cartesian differential form. Use usual notations and symbols. 03

3A. A nozzle of diameter 20 mm is fitted to a pipe of diameter 40 mm. Find the force exerted by water on the nozzle, if the water is flowing through the pipe at the rate of 20 *lps*. 02

3B. Find the discharge of water flowing through a pipe 30 cm diameter placed in an inclined position where a venturimeter is inserted, having a throat diameter of 15 cm. The difference of pressure between the main and throat is measured by a liquid of specific gravity 0.6 in an inverted U-tube which gives a reading of 30 cm. The loss of head between the main and throat is 0.2 times the kinetic head of the pipe. 03

3C. In case of viscous flow through circular cross section pipe, show that the shear stress distribution along the radial direction is linear. 02

3D. Derive the Chezy's formula for determining the head lost due to viscous friction. 03

4A. An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2 m is 3 MPa. The width of the plates is 200 mm. 02

4B. Determine the rate of flow of water through a pipe of diameter 20 cm and length 50 m when one end of the pipe is connected to a tank and other end of the pipe is open to the atmosphere. The pipe is horizontal and the height of water in the tank is 4 m above the center of the pipe. Consider all minor losses and take the coefficient of friction, f = 0.009 in the Darcy's formula. 03

4C. Explain (i) Reynold's model law, and (ii) Mach model law. 02

4D. The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Using Buckingham pi theorem, express the efficiency η in terms of dimensionless parameters. 03

5A. Using Rayleigh's method, find the expression for the power P, developed by a pump when P depends upon the head H, the discharge Q and specific weight γ of the fluid. 02

5B. With a neat sketch explain the formation of boundary layer when a fluid with uniform velocity flows over a horizontal fixed plate. Show how to identify the laminar and turbulent boundary layers. 02

5C. Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m^3. The coefficients of lift and drag are 0.75 and 0.15 respectively. Determine :
(i) The lift force, (ii) The drag force, (iii) The power exerted by air on the plate. 03

5D. Find the displacement thickness, momentum thickness and energy thickness in the boundary layer when the velocity distribution in the boundary layer is given by $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$, where '$u$' is the velocity at a distance 'y' from the plate and $u = U$ at $y = \delta$, where δ is the boundary layer thickness. 03

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