Exam No: _____

GANPAT UNIVERSITY

B. TECH SEM-III[rd] (ME/MEint)

CBCS REGULAR EXAMINATION– NOV/DEC 2016

2ME304: FLUID MECHANICS

TIME: 3 HRS **TOTAL MARKS: 60**

Instructions: (1) This question paper has two sections. Attempt each section in separate answer book.
(2) Figures on right indicate marks.
(3) Be precise and to the point in answering the descriptive questions.

SECTION: I

Q.1 (a) Which property is responsible for the spherical shape of rain drop? Explain that property with neat sketch. **(04)**

(b) Define: (i) Specific volume (ii) Dynamic viscosity (iii) Kinematic viscosity **(03)**

(c) A simple manometer is used to measure the pressure of oil (sp. Gr. 0.8) flowing in a pipe line. Its right limb is open to the atmosphere and left limb is connected to the pipe. The centre of the pipe is 9 cm below the level of mercury (sp. Gr. 13.6) in the right limb. If the difference of mercury level in the two limbs is 15 cm, determine the absolute pressure of the oil in the pipe in N/cm^2. **(03)**

OR

Q.1 (a) Prove that the rate of increase of pressure in vertically downward direction in a static liquid is equal to the specific weight of fluid at that point. **(04)**

(b) State and prove Pascal's law **(03)**

(c) Calculate the capillary effect in millimeters in a glass tube of 4 mm diameter, when immersed in (i) water and (ii) mercury. The temperature of the liquid is 20 ^{0}C in contact with air are 0.073575 N/m and 0.51 N/m respectively. The angle of contact for mercury is 130^0. Take density of water at 20 ^{0}C as equal to 998 kg/m^3. **(03)**

Q.2 (a) A fluid of density ρ and viscosity μ, flows at an average velocity V through a circular pipe of diameter D. Show by dimensional analysis, that the shear stress at the pipe wall is given as, $\tau_0 = \rho V^2 \varphi \left[\frac{\rho V D}{\mu}\right]$. **(04)**

(b) The pressure difference Δp in a pipe of diameter D and length L due to turbulent flow depends on the velocity V, viscosity μ, density ρ and roughness k. Using Buckingham's π-theorem, obtain an expression for Δp. **(04)**

(c) Give the dimensions of (i) Dynamic viscosity (ii) Kinematic viscosity. **(02)**

OR

Q.2 (a) The resisting force R of a supersonic plane during flight can be considered as dependent upon the length of the aircraft L, velocity V, air viscosity μ, air density ρ and bulk modulus of air K. Express the functional relationship between these variables and the resisting force by Rayleigh's method. **(04)**

(b) Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends upon the angular velocity ω, speed of advance V, diameter D, dynamic viscosity μ, mass density ρ, elasticity of the fluid medium which can be denoted by the speed of sound in the medium C. **(04)**

(c) Define and explain dimensional homogeneity. **(02)**

Q.3 **Attempt any two from the following.** **(10)**

(a) Derive an expression for area-velocity relationship for a compressible fluid in the form, $\frac{dA}{A} = \frac{dV}{V}[M^3 - 1]$.

(b) A gas is flowing through a horizontal pipe which is having area of cross-section as 40 cm^2, where pressure is 40 N/cm^2 (gauge) and temperature 15 ^0C. At another section the area of cross-section is 20 cm^2 and pressure is 30 N/cm^2 (gauge). If the mass rate of flow of gas through the pipe is 0.5 kg/s, find the velocities of the gas at these sections, assuming an isothermal change. Take R = 292 N-m/kg K, and atmospheric pressure = 10 N/cm^2.

(c) Define similitude. Explain the different types of similarity in model analysis.

SECTION: II

Q.4 (a) Derive continuity equation in three dimensions for kinematics of flow. **(03)**

(b) The velocity vector in a fluid flow is given by $V=4x^3i - 10x^2yj + 2tk$. Find the velocity of a fluid particle at *(1, 2, 3)* at time $t = 1$. **(03)**

(c) Water flows through a pipe AB 1.2 m diameter at 3 m/s and then passes through a pipe BC 1.5 m diameter. At C, the pipe branches. Branches CD is 0.8 m in diameter and carries 1/3(one-third) of flow in AB. The flow velocity in branch CE is 2.5 m/s. Find the volume rate of flow in AB, the velocity in BC, the velocity in CD and the diameter of CD. **(04)**

OR

Q.4 (a) Derive Expression for the rate of flow through Venturimeter. **(03)**

(b) Prove that Bernoulli's equation of motion is the modification of Euler's equation of motion. **(03)**

(c) A 30 cm × 15 cm venturimeter is inserted in vertical pipe carrying water, Flowing in the upward direction. A differential mercury manometer connected to the inlet and throat gives a reading of 20cm. Find the discharge. Take $C_d=0.98$. **(04)**

Q.5 (a) Prove that velocity is maximum at half of the pipe diameter in viscous flow. **(05)**

(b) An oil of viscosity is 0.1 Ns/m^2 and relative density is 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of flow of fluid through pipe is 3.5 liter/s. Find the pressure drop in a length of *300 m* and also the shear stress at the pipe wall. **(05)**

OR

Q.5 (a) Prove that the ratio of maximum velocity to average velocity between two plates in viscous flow is 3/2. **(05)**

(b) An oil of viscosity 10 poise flows between two parallel plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between two plates of the drop of pressure in a length of 1.2 m be 0.3 N/cm^2. Width of the plate is 200 mm. **(05)**

Q.6 **Attempt any two.** **(10)**

(a) Prove that the head loss due to friction is directly proportional to length of pipe.

(b) Calculate (a) the pressure gradient along flow, (b) the average velocity and (c) discharge of an oil of viscosity 0.02 Ns/m^2 flowing between two stationary parallel plates 1 m wide maintained 10 mm apart. The velocity midway between the plates is 2 m/s.

(c) Water at 15°C flows between two large parallel plates at a distance of 1.6 mm apart. Determine (a) the maximum velocity (b) the pressure drop per unit length and (c) the shear stress at the walls of plates if average velocity is 0.2 m/s. The viscosity of water at 15°C is given 0.01 poise.

END OF PAPER