

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/Backlog), November-December 2017

M. Tech. in Mechanical Engineering, Semester: 1st

Roll No.....

TEMTech102 : Viscous Fluid Flows

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark)

10

- i. Newton's law of viscosity depends upon the
 - (a) Stress and strain in the fluid
 - (b) Shear stress, pressure and velocity
 - (c) Shear stress and rate of strain
 - (d) Viscosity and shear stress
- ii. The normal stresses is same in all directions at a point in a fluid only when
 - (a) The fluid is frictional
 - (b) The fluid is frictionless and incompressible
 - (c) The fluid has zero viscosity and is at rest
 - (d) One fluid layer has no motion relative to an adjacent layer
- iii. What are the dimensions of kinematic viscosity of a fluid?
 - (a) LT^{-1}
 - (b) L^2T^{-1}
 - (c) $ML^{-1}T^{-1}$
 - (d) $ML^{-2}T^{-2}$
- iv. The curl of a given velocity field ($\nabla \times \vec{V}$) indicates the rate of
 - (a) Increase or decrease of a flow at a point
 - (b) Twisting of the lines of flow
 - (c) Deformation
 - (d) Translation
- v. The SI unit of kinematic viscosity is
 - (a) m^2/sec
 - (b) $kg/m.sec$
 - (c) m/sec^2
 - (d) m^3/sec^2
- vi. All experiments thus far indicate that there can be a laminar flow in a pipe if the Reynold's number is below
 - (a) 2300
 - (b) 4000
 - (c) 2000
 - (d) 40,000
- vii. The hydraulic mean depth (Where A = area and p = Perimeter) is given by
 - (a) $\frac{p}{A}$
 - (b) $\frac{p^2}{A}$
 - (c) $\frac{A}{p}$
 - (d) $\sqrt{\frac{A}{p}}$
- viii. When a vertical cylindrical vessel containing water is rotated about its axis, then the free surface of water becomes
 - (a) A cycloid of revolution
 - (b) An ellipsoid of revolution
 - (c) A hyperboloid of revolution
 - (d) A paraboloid of revolution
- ix. The eye of a tornado has a radius of 40 m. If the maximum wind velocity is 50 m/s, The velocity at a distance of 80 m radius is

- (a) 100 m/s (b) 2500 m/s (c) 31.25 m/s (d) 25 m/sec
- x. An incompressible fluid flows radially outward from a line source in a steady manner. How does velocity in any radial direction vary?
- (a) r (b) r^2 (c) $\frac{1}{r}$ (d) $\frac{1}{r^2}$

Q.2 Short answer type questions (4 questions @ 2.5 marks) 10

- i. Explain creeping flow in detail with suitable example.
- ii. What is immiscible flow?
- iii. In a turbulent flow, L is the Prandtl's mixing length and $\frac{\delta \bar{u}}{\delta y}$ is the gradient of the average velocity in the direction normal to flow. The final expression for the turbulent viscosity ν_t is given by?
- iv. Water flow through a smooth circular pipe of diameter D and length ' L ' because of a pressure difference Δp across the length. The volume flow rate is ' Q ' and the flow is turbulent with reynold's number of 10^5 . If the pressure difference is increased to $4\Delta p$. What will be the volume flow rate?

Q.3A Define the degree of turbulence with suitable example. 05

Q.3B Differentiate between hydro-dynamically rough surface and a hydro-dynamically smooth surface with the help of neat sketches. 05

Q.4A Is it possible to describe a turbulent flow by the equation $u = 5 + 0.5 \sin t$, then calculate (i) $\bar{u}$ (ii) $(\bar{u}^2)^{\frac{1}{2}}$ 05

Q.4B Explain the terms slip and slip factor, write expressions for these terms. 05

Q.5A A 5 cm diameter horizontal jet of water, with a velocity of 30 m/s, strikes the tip of a horizontal cone which deflects the water by 45° from its original direction. How much force is required to hold the cone against the water stream. 05

Q.5B Define boundary layer thickness in detail with neat sketch. 05

Q.6A A rough pipe of diameter 0.1 m carries water at 20°C at the rate of 50 Liters per second. If the average height of the roughness projections on the pipe surface is 0.15 mm. Determine friction. 05

Q.6B Explain the concept of Prandtl's mixing length hypothesis. 05

OR

Q.6B The $\frac{1}{7}$ power law for turbulent boundary layer is not applicable very near to the solid boundary. Do you agree? If yes, why? Justify 05

Q.7A For the velocity distribution prescribed by $\frac{u}{u_0} = \left(\frac{y}{\delta}\right)^{\frac{1}{7}}$ show that the ratio of displacement thickness $(\delta^*)'$ to momentum thickness (θ) is 1.285. 05

Q.7B A flow field is defined by $u = 2y$ and $v = xy$. Derive expressions for the 05

acceleration components. Find the magnitude of the velocity and acceleration at the point (2, 3). Specify units in terms of L & T.

OR

- Q.7B A hydraulic lift which is used for an automobiles consists of a 280 mm diameter ram that slides in a 280.18 mm cylinder. The annular space between the ram and cylinder is filled with oil having a kinematic viscosity of $0.00042 \text{ m}^2/\text{s}$ and specific gravity of 0.86. If the rate of travel of the ram is 0.22 m/s , find the frictional resistance when 2 m of the ram is engaged in the cylinder. 05
- Q.8A Distinguish different types of flows prevailing in fluid flow problems. 10
- Q.9A Explain separation of flow in details with suitable example. 10
- Q.9B Discuss the methods used controlling of separation in a diffuser. 10