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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

Course Code: ME203

Course Name: MECHANICS OF FLUIDS (ME)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Differentiate between ideal fluids and real fluids. Mark those on rheological diagram. (4)

b) A plate weighing 150N and measuring 0.8mx0.8m slides down an inclined plane over an oil film of 1.2mm thickness for an inclination of 30^o and a velocity of 0.2m/s. Compute the dynamic viscosity of the fluid. (6)

2 a) What is metacentre? Explain the equilibrium conditions of floating bodies. (4)

b) A triangular plate of base width 2m and height 3m is immersed in water with its plane making an angle of 60^o with the free surface of water. Determine the hydrostatic pressure force and the centre of pressure when the apex of the triangle lies 5m below the free water surface. (6)

3 a) Explain the working principle and use of the following devices. (6)
i) Hydraulic lift ii) Piezometer iii) Bourden tube pressure gauge

b) Differentiate between rotational and irrotational fluid flow. (4)

4 a) Define the following with example. (4)
i) Stream lines ii) Stream tube iii) Path lines iv) Streak lines

b) The stream function for a flow field is given by $\Psi = 2xy$. Check whether the flow is continuous or irrotational. (6)

PART B

Answer any three full questions, each carries 10marks.

5 a) Derive Euler's equation of motion. Obtain Bernouli's equation from Euler's equation. (6)

b) What are the applications and limitations of Bernouli's equation? (4)

6 a) What is Venturimeter? Derive an expression for discharge through a venturimeter. (6)

b) Water flows at the rate of 15litre/s through a pipe 100mm diameter orifice used in a 200 mm diameter pipe. What is the difference of pressure head between upstream section and vena contracta section? Take coefficient of contraction as 0.6 and coefficient of velocity as 1. (4)

7 a) Differentiate between laminar and turbulent flows. (4)

b) Derive Darcy- Weisbach equation. (6)

8 a) Explain the causes of major and minor energy losses in pipe flows. (4)

b) Glycerine flows at a velocity of 5m/s in a 10cm diameter pipe. Dynamic viscosity and density of glycerine is assumed as 1.50Pa.s and 1260kg/m^3 respectively. Estimate: i) The boundary shear stress in the pipe due to the flow. (6)
ii) Head loss in a length of 10m of pipe.
iii) Power developed by the flow in a distance of 10m.

PART C

Answer any four full questions, each carries 10marks.

9 Determine the displacement thickness, momentum thickness and energy thickness in terms of normal boundary layer thickness δ in respect of the following velocity profile in the boundary layer on a flat plate $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$ where u is the velocity at height y above plate surface and U is the free stream velocity. (10)

10 Obtain Von – Karman momentum integral equation from conservation principles. (10)

11 a) Derive an expression for i) displacement thickness and ii) momentum thickness. (6)

b) A 2.5m ship model was tested in fresh water (ρ=1000kg/m^3) and measurements indicated that there was a resistance of 45N when the model was moved at 2m/s. Work out the velocity of 40m prototype. Also calculate the force required to drive the prototype at this speed through sea water (ρ =1025kg/m^3). (4)

12 a) Define the following: i) boundary layer thickness ii) displacement thickness iii) momentum thickness and iv) energy thickness. (4)

b) Explain: i)Geometric similarity ii)Kinematic similarity iii) Dynamic similarity. (6)

13 Show that the power P developed in a water turbine can be expressed as: $P = \rho N^3 D^5 \Phi\left\{\frac{D}{B},\ (\rho D^2 N)/\mu, \frac{H}{D},\ ND/\sqrt{gH}\right\}$ where D and B are diameter and width of runner, N is the speed in rpm; H is the operating head, μ and ρ are respectively the coefficient of dynamic viscosity and mass density of the liquid. (10)

14 Define the following dimensionless number with their field of application: (10)
i) Froude Number ii) Weber Number iii) Newton number iv) Mach number

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