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BIME-006

B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)

00595

Term-End Examination
December, 2014

BIME-006 : THERMOFLUID ENGINEERING

Time : 3 hours *Maximum Marks : 70*

Note : *Answer any **five** questions. Assume suitably any missing data.*

1. (a) Derive the continuity equation for a three-dimensional, steady incompressible flow. *8*

(b) A pipe AB branches into two pipes C and D. The pipe has diameter of 45 cm at A, 30 cm at B, 20 cm at C and 15 cm at D. Determine the discharge at A, if the velocity at A is 2 m/sec. Also determine the velocities at B and D, if the velocity at C is 4 m/sec. *6*

2. (a) Derive Euler's equation of motion along a streamline and hence derive the Bernoulli's equation. *8*

(b) A non-uniform part of a pipeline 5 m long is laid at a slope of 3 in 5. Two pressure gauges each fitted at the upper and lower ends read 20 N/cm^2 and 12·5 N/cm^2. If the diameter at the upper and lower ends are 15 cm and 10 cm respectively, determine the quantity of water flowing per second through the pipe. *6*

3. (a) Show that the sonic velocity in an ideal gas depends on the temperature and the nature of gas. *8*

(b) An airplane is flying at an altitude of 15 km, where the temperature is – 50°C. The speed of the plane corresponds to Mach number of 1·6. Assuming γ = 1·4 and R = 0·287 kJ/kg K for air, find the speed of the plane and Mach angle α. *6*

4. (a) Show that the discharge through a nozzle is maximum when there is a sonic condition at its throat. *8*

(b) Air flows through a convergent-divergent nozzle. At some section in the nozzle, pressure = 2 bar, velocity = 170 m/sec and temperature = 200°C and cross-sectional area = 1000 mm^2. Assuming isentropic flow conditions, determine the *6*

(i) stagnation temperature and pressure.

(ii) sonic velocity and Mach number at this section.

(iii) velocity, Mach number and flow area at outlet section, where pressure is 1·1 bar.

5. (a) What is the normal shock wave and how is it obtained ? How does the normal shock affect

(i) fluid velocity ?

(ii) static temperature and stagnation temperature ?

(iii) static pressure and stagnation pressure ? *8*

(b) Normal shock occurs in the diverging section of a nozzle under steady flow conditions at a point, where the air is at 150 kPa and 300 K travelling at 1000 m/sec. What are the pressure and temperature on the subsonic side of the point ? If the surroundings are at 20°C, what is the irreversibility caused by the shock process ? *6*

6. (a) Prove that for a steady laminar flow between two fixed parallel plates, the velocity distribution across a section is parabolic and that the average velocity is $2/3^{rd}$ of the maximum velocity. *8*

(b) A horizontal circular pipe of 50 mm diameter and 750 mm length maintains water flow rate of 0·03 m^3/min. Calculate the head loss due to friction and the power required to maintain the flow if $\mu = 1{\cdot}14 \times 10^{-3}$ NS/m^2 and $f = 0{\cdot}008$. *6*

7. (a) Deduce an expression for the specific speed of a hydrodynamic machine and point out how the classification of hydrodynamic runners is based on specific speed. *8*

(b) The following data refers to the runner of a Kaplan turbine which yields 8850 kW at the turbine shaft. Net available head = 5·5 m, speed ratio = 2·1, flow ratio = 0·67 and overall efficiency is 85%. Assuming that hub diameter of the wheel is 0·35 times the outside diameter, find the runner diameter and its speed. *6*

8. Write short notes on any ***two*** of the following : *7×2=14*

(a) Governing of turbines

(b) Basic components of total drag

(c) Off design in nozzles