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BIME-006

B.Tech. MECHANICAL ENGINEERING (BTMEVI)

00034

Term-End Examination

June, 2014

BIME-006 : THERMOFLUID ENGINEERING

Time : 3 hours *Maximum Marks : 70*

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

1. (a) Distinguish between : 8

   (i) Laminar and turbulent flow

   (ii) Steady and unsteady flow

   (iii) Uniform and Non-uniform flow

   (iv) Compressible and incompressible flow

   (b) Water flows through a pipe AB of diameter $d_1 = 50$ mm which is in series with a pipe of diameter $d_2 = 70$ mm in which the mean velocity $V_2 = 3$ m/sec. At C the pipe forks and one branch CD is of diameter d_3 such that the mean velocity V_3 is 1.5 m/sec. The other branch CE is of diameter $d_4 = 35$ mm and the conditions are such that the discharge Q_2 from BC divides so that $Q_4 = \left(\frac{Q_3}{2}\right)$. Calculate the values of Q_1, V_1, Q_2, Q_3, d_3, Q_4 and V_4. 6

2. (a) Derive Bernoulli's equation starting from fundamentals and state all the assumptions made. 8

(b) A tapering pipe is running full of water. The pipe is placed vertically with the diameter at the base and top being 1.2 m and 0.6 m respectively. The pressure at the upper end is 240 mm of Hg, while the pressure at the lower end is 15 kN/m^2. Assume the head loss to be 20% of difference in the velocity head. Calculate the discharge if the flow is vertically upwards and the difference of elevation is 3.9 m. 6

3. (a) Write down the continuity, momentum and energy equation for compressible flow. How these relations compare with the corresponding equation for incompressible flow ? 6

(b) Determine the velocity of a bullet fired in the air if Mach angle observed to be 30°. Given that temperature of air is 22°C, density 1.2 kg/m^3. Take $\gamma = 1.4$ and $R = 287.4$ J/kgK. 8

4. (a) Explain the effect of area ratio as a function of Mach number in an isentropic nozzle. 8

(b) A supersonic nozzle in to be designed for air flow with Mach number 3 at the exit section which is 250 mm in diameter. The pressure and temperature of air at the nozzle exit are 8.5 kN/m^2 and 215 K. Make calculations for : 6

(i) reservoir pressure and temperature and

(ii) throat area

5. (a) What is a normal shock and how it is obtained ? How the velocity, temperature, density and entropy change across a normal shock wave ? 8

(b) A 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 wave front ? If the surroundings are at 20°C, what is the irreversibility caused by the shock process ? 6

6. (a) Derive Darcy's formula to calculate the frictional head in a pipe. Explain briefly major and minor energy losses in flow through pipes. 8

(b) Two pipes of the same material and of equal length are available for connection to an overhead tank which can supply 0.085 m^3/sec of water. The diameter of pipes are 40 cm and 20 cm respectively. Determine the ratio of the head loss when the pipes are connected in series to the head loss when they are connected in parallel. Neglect minor losses. 6

7. (a) Discuss in general the main operating characteristics of a hydraulic turbine. Which of the Pelton, Francis and Propeller turbines gives better off- design performance and why ? 8

(b) A pelton wheel having semi-circular buckets functions under a head of 150 m and consumes 50 litres per second of water. If 60 cm diameter wheel turns 600 rpm, calculate the power available at the nozzle and the hydraulic efficiency of the wheel. Take pressure coefficient as unity. 6

8. Write short notes on **any two** of the following : 7+7

(a) Cavitation in turbine

(b) Turbulence modelling

(c) Fanno line and Rayleigh line