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BIME-002

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B.Tech. MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

June, 2014

BIME-002 : THERMAL ENGINEERING - I

Time : 3 hours *Maximum Marks : 70*

*Note : Attempt **any five** questions. Use of **steam tables** and **Mollier's chart** is allowed.*

1. (a) State and derive the Maxwell's relations. Explain their importance in thermodynamics. 7

   (b) Using the cyclic equation prove that $\left(\frac{\partial P}{\partial T}\right)_v = \frac{\beta}{K_T}$ where β is coefficient of expansion and K_T is isothermal compressibility. 7

2. (a) The volumetric analysis of a sample of producer gas supplied to an engine is $H_2 = 20\%$, $CH_4 = 3\%$, $CO = 22\%$, $CO_2 = 8\%$ and $N_2 = 47\%$. 7

   (i) Find the volume of air required for complete combustion of one m^3 of the gas.

   (ii) If 50% excess air is supplied, find the percentage contraction in volume after the products of combustion have been cooled.

(b) Define calorific value of fuel. Differentiate between H.C.V. and L.C.V. of a fuel and state which value is used in calculations and why ? 7

3. (a) Describe with a neat sketch the working of cochran boiler. 7

(b) Define chimney efficiency and derive an expression for the same. 7

4. (a) Draw T - S diagram of Rankine cycle using dry saturated steam and develop the equation for the Rankine cycle efficiency. 7

(b) Steam expands from 3 bar to 1 bar in a nozzle. The initial velocity is 90 m/s and the initial temperature is 150°C. The nozzle efficiency is 0.95. Determine the exit velocity. 7

5. (a) What is the fundamental difference between the operation of impulse and reaction turbines ? Explain the same with neat sketches. 7

(b) In a single stage impulse turbine the blade angles are equal and the nozzle angle is 20°. The velocity coefficient for the blade is 0.83. Find the maximum blade efficiency possible. If the actual blade efficiency is 90% of maximum blade efficiency, find the possible ratio of blade speed to steam speed. 7

6. (a) Describe with the neat sketches the working of a simple constant pressure open cycle gas turbine. How does the actual cycle differ from the theoretical cycle ? 7

(b) In an open constant pressure gas turbine, air enters the compressor at 1.02 bar and 27°C. The pressure of air after the compression is 4.08 bar. The isotropic efficiencies of compressor and turbine are 80% and 85% respectively. The A : F ratio used is 80 : 1. Find the I.P. and thermal efficiency of the cycle if the flow rate of air is 2.5 kg/sec. Take $C_P = 1$kJ/kg-K and $Y = 1.4$ for air and gases. C.V. of fuel used = 41720 kJ/kg. 7

7. Write short notes on : **4x3½=14**

(a) Reheat Rankine Cycle
(b) Principles of Jet Propulsion
(c) Evaporative Condenser
(d) Binary Vapour Cycle