No. of Printed Pages : 3

BIME-002

01454

B.Tech. MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

June, 2011

BIME-002 : THERMAL ENGG - I

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **any five.** Use of **steam tables** and **Mollier's chart** is allowed. Use of non-programmable scientific calculator is permitted*

1. (a) Using the properties in differential form, derive the Maxwell relations. 7

   (b) Using the Clapreyon equation, estimate the enthalpy of vaporisation at 110°C and compare the same with tabulated value. 7

2. (a) Explain adiabatic flame temperature and derive its equation. 7

   (b) The products of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by Orsat apparatus 7

   $CO_2 = 8\%$, $CO = 0.9\%$, $O_2 = 8.8\%$ and $N_2 = 82.3\%$. Determine :

   (i) Composition of the fuel.

   (ii) Air-fuel ratio

   (iii) Percentage excess air used.

3. (a) How are the boilers classified ? Compare water tube and fire tube boilers. 7

(b) Estimate the condenser cooling water flow rates for a 400 MW power plant if the water undergoes 10°C temperature rise. Assume overall plant efficiency 40% and boiler efficiency 80%. 7

4. (a) Steam at 20 bar and 360°C expands in a steam turbine to 0.08 bar. It is then condensed in a condenser to saturated water. The pump feed back water to boiler. Assure ideal Rankine cycle and determine (i) Net work done/kg of steam (ii) Rankine efficiency. 7

(b) In a convergent-divergent nozzle the steam enters at 15 bar, 300°C and leaves it at a pressure of 2 bar. The inlet velocity to the nozzle is 150 m/sec. Find the required throat and exit areas for mass flow rate of 1 kg/sec. Assume nozzle efficiency to be 90% Assume $C_p = 2.4$ kJ/k_gK. 7

5. (a) Explain basic Rankine cycle. Explain the effect of increase of boiler and condenser pressures. 7

(b) Steam leaves the nozzle of a single stage impulse turbine at 840m/sec. The nozzle angle is 18° and the blade angles are 29° at inlet and outlet. The friction factor is 0.9. Calculate : 7

(i) Blade velocity

(ii) Steam mass flow rate in kg/hr to develop 300 kW power.

6. (a) The compressor and turbine unit of a small gas turbine plant have an isentropic efficiency of 85%. The inlet air temperature to the compressor is at 15°C and the maximum temperatur during the cycle is limited to 700°C. The pressure ratio is .4. Assuming $C_p = 1.1$ and $C_v = 0.786$ kJ/kgK, calculate the specific output and overall efficiency of the cycle. Neglect all other losses. 7

(b) Derive an expression for air standard efficiency of ideal Brayton cycle interms of pressure ratio. 7

7. Write short notes on : **4x3½=14**

(a) Basic principle of Jet Propulsion Devices.

(b) Impulse and Reaction turbines.

(c) Working of Surface Condenser.

(d) Boiler mountings.