

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

Term-End Examination

June, 2015

00876

BIME-002 : THERMAL ENGINEERING – I

Time : 3 hours

Maximum Marks : 70

Note : *Attempt any seven questions. Assume missing data suitably, if any. Use of steam tables is permitted. Use of calculators is permitted.*

1. Explain the Clapeyron Equation. 10

2. The percentage composition of a sample of liquid fuel by weight is : C = 84%, H₂ = 9.2%, Oxygen = 6%, remaining Ash. Determine
 - (i) minimum mass of air required per kg of fuel for combustion,
 - (ii) total air supplied for combustion if 15% excess air is supplied,
 - (iii) total mass of N₂ in dry products. 10

3. What do you mean by High Pressure Boiler ? Explain, with a neat sketch, the working principle of Benson Boiler. 10

4. A steam boiler evaporates 18000 kg/hr of steam at 12.5 bar and a quality of 0.95 from feed water at 105°C when the coal is fired at the rate of 2000 kg/hr. If the higher C.V. of coal is 27400 kJ/kg, determine
- (i) heat rate of boiler in kJ/hr,
 - (ii) equivalent evaporator and
 - (iii) thermal efficiency. 10
5. Explain clearly what do you mean by saturation curve and missing quantity. Suggest the ways by which missing quantity can be reduced. 10
6. Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine
- (i) the exit velocity of the steam,
 - (ii) the ratio of cross-section at exit to throat area. 10
7. Steam at a pressure of 150 bar and 550°C expands through a high pressure turbine. It is reheated at a pressure of 40 bar to 550°C and expands in a low pressure turbine to a condenser at 0.1 bar. Determine the
- (i) quality of steam at turbine exhaust,
 - (ii) cycle efficiency and
 - (iii) steam rate in kg/kW hr. 10

8. Show that blade speed ratio $\rho = \frac{\cos \alpha}{2}$ for maximum blade efficiency of impulse turbine and hence show that the maximum efficiency of impulse turbine is $(\eta_b)_{\max} = \cos^2 \alpha$. 10

9. A gas turbine unit has pressure ratio of 6 and maximum cycle temperature of 610°C . The isentropic efficiencies of compressor and turbine are 80% and 82% respectively. Find the cycle efficiency and power output in kW, when air enters the compressor at 15°C at the rate of 16 kg/s.

Take $C_p = 1.005 \text{ kJ/kg K}$, $\gamma = 1.4$ for compression

$C_p = 1.11 \text{ kJ/kg K}$, $\gamma = 1.33$ for expansion. 10

10. Write short notes on the following : 2×5=10

(a) Turbojet Engine

(b) Surface Condenser
