| BIME-002 |

B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)
Term-End Examination
00765 December, 2014

BIME-002 : THERMAL ENGINEERING – I

Time : 3 hours   *Maximum Marks : 70*

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

1. (a) Derive Clapeyron's equation. What are its uses and limitations ?   7

   (b) For the following differential equation

   dg = V.dp – S.dT,

   write the corresponding Maxwell's equation.   7

2. (a) The percentage analysis of gaseous fuel by volume is given as follows :   7

   CO_2 = 8%, CO = 22%, O_2 = 4%, H_2 = 30%, N_2 = 36%

   Determine the minimum volume of air required for complete combustion of 1 m^3 of gas and calculate the percentage composition by volume of the dry products of combustion.

(b) Describe the method of finding the calorific value of coal. Describe how cooling correction is obtained in this method. 7

3. (a) Explain why safety valves are needed in a boiler. Draw a neat sketch of spring loaded safety valve and explain its working. 7

(b) A boiler plant delivers steam at 2 bar and 300°C to a steam engine developing 1400 kW at the rate of 10 kg/kWh. Temperature of feed water is 80°C and C.V. of fuel used is 27,500 kJ/kg.

The grate is to be designed to burn 400 kg of coal per m^2 per hour. Find the grate area required for the above duty assuming the combustion efficiency of 90% and boiler efficiency including superheater at 75%. 7

4. (a) Explain the sequence of operations of the modified Rankine cycle used in steam engines and give reasons for its adoption. 7

(b) The inlet condition of steam to a convergent divergent nozzle is 2.2 MN/m^2 and 260°C. The exit pressure is 0.4 MN/m^2. Assuming frictionless flow up to the throat and a nozzle efficiency of 85 percent, 7

(i) determine the flow rate for a throat area of 32.3 cm^2,

(ii) determine the exit area.

5. (a) What are the different methods of compounding of steam turbine stages ? List the advantages and limitations of velocity compounding. 7

(b) A single row steam turbine develops 115 kW at a blade speed of 180 m/sec when the steam flow is 2 kg/sec. Steam leaves the nozzle at 400 m/sec. The velocity coefficient of the blade is 0·9. Steam leaves the blades axially. Determine the nozzle angle and blade angles assuming no shock. 7

6. (a) What are the advantages and disadvantages of gas turbines over I.C. engines ? What are the fields of application for gas turbine power plant ? 7

(b) In a simple gas turbine plant, air enters at 1 bar and 20°C and is compressed with isentropic efficiency of 80% to 4 bar. Then it is heated in combustion chamber with A : F ratio = 90 : 1. The C.V. of fuel used is 41·8 MJ/kg. If the air flow is 3 kg/sec, find the power developed and thermal efficiency of the plant. C_p = 1 kJ/kg °C and γ = 1·4 for air and gas both. 7

7. Write short notes on the following : $4 \times 3\frac{1}{2} = 14$

   (a) Principle of Rocket propulsion

   (b) Regenerative Rankine cycle

   (c) Turbojet and turboprop engine

   (d) Cogeneration

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