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BIME-002

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

Term-End Examination

June, 2016

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BIME-002 : THERMAL ENGINEERING – I

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **seven** questions. Use of Steam tables is permitted. Use of calculator is allowed.*

1. (a) What are primary fuels ? List some important primary fuels.

(b) What is the difference between higher heating value (HHV) and lower heating value (LHV) of the fuel ? *5+5*

2. (a) What is a fusible plug ? State where it is located in a boiler.

(b) Define 'Steam nozzle'. Explain with the help of neat diagrams, the various types of nozzles. *5+5*

3. In a boiler test, 1250 kg of coal is consumed in 24 hours. The mass of water evaporated is 13000 kg and the mean effective pressure is 7 bar. The feed water temperature was 40°C, heating value of coal is 30000 kJ/kg. The enthalpy of 1 kg of steam at 7 bar is 2570·70 kJ.

Determine :

(a) Equivalent evaporation per kg of coal

(b) Efficiency of the boiler *10*

4. A spark ignition engine has a fuel-air ratio of 0·067. How much kg of air per hour is required for a brake power output of 73·6 kW at an overall thermal efficiency of 20% ? Calorific value of the fuel is 42000 kJ/kg. *10*

5. At a particular stage of a reaction turbine, the mean blade speed is 60 m/s and the steam is at a pressure of 350 kN/m^2 with a temperature of 175°C. Fixed and moving blades of this stage have inlet angles of 30° and exit angles of 20°. Determine the blade height, if the blade height is one-tenth of the mean blade ring diameter and steam flow is 13·5 kg/sec at 350 kN/m^2 and 175°C. The specific volume of steam is 0·589 m^3/kg. *10*

6. Air is expanded reversibly and adiabatically in a nozzle from 13 bar and 150°C to a pressure of 6 bar. The inlet velocity of the nozzle is very small and the process occurs under steady state flow conditions. Calculate the exit velocity of the nozzle. *10*

7. A turbojet engine flying at a speed of 960 km/h consumes air at the rate of 54·5 kg/s.

   Calculate

   (a) Exit velocity of the jet when the enthalpy change for the nozzle is 200 kJ/kg and velocity coefficient is 0·97,

   (b) Fuel flow rate in kg/s when the air-fuel ratio is 75 : 1,

   (c) Thrust specific fuel consumption,

   (d) Thermal efficiency of the plant when the consumption efficiency is 93% and calorific value of the fuel is 45000 kJ/kg,

   (e) Propulsive power,

   (f) Propulsive efficiency, and

   (g) Overall efficiency. *10*

8. An engine uses a fuel of CV of 42000 kJ/kg and has a specific gravity of 0·75. The engine develops a brake power of 29·44 kW. The brake thermal efficiency of the engine is 24%. Determine the volume of the fuel consumed per second. *10*

9. A gas turbine is supplied with a gas at 5 bar and 1000 K and expands it adiabatically to 1 bar. Determine the exhaust gas temperature.

   Take C_p = 1·0424 kJ/kg K,

   C_v = 0·7662 kJ/kg K. *10*

10. Air enters the compressor of a gas turbine plant operating on Brayton cycle at 1 bar, 27°C. The pressure ratio of the cycle is 6. If $W_T = 2{\cdot}5\ W_C$, where W_T and W_C are the turbine and compressor work respectively, calculate the maximum temperature of the plant. Also determine the cycle efficiency.

    Take C_p = 1 kJ/kg K. *10*