BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING) BTMEVI

Term-End Examination

December, 2011 00242

BME-019 : ENGINEERING THERMODYNAMICS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **any seven** questions. All questions carry **equal** marks. Use of scientific calculator is permitted. Use of steam - table is also permitted.*

1. (a) State thermodynamic definition of work. Also differentiate between heat and work. **5+5**

(b) Calculate the work done in a piston - cylinder arrangement during the expansion process, where the process is given by $p = (V^2 + 6V)$ bar,

The volume changes from $1 m^3$ to $4 m^3$ during expansion.

2. (a) Define an isolated system. What is a thermodynamic cycle ? **5+5**

(b) A mass of 1.5 kg of air is compressed from 0.1 MPa to 0.7 MPa by the relation pV = constant. If the initial density of air is 1.16 kg/m^3, find the work done by the piston to compress the air.

3. (a) A resistance thermometer has a resistance of 3 Ω at ice point and 4 Ω at steam point. What will be the temperature when the resistance is 6.2 Ω ? 5+5

(b) Explain in brief the zeroth law of thermodynamics.

4. (a) The work output and heat input for a process A are 40 kJ and 17 kJ respectively. Another process B between the same given conditions involve a heat transfer of 19 kJ. Determine the change in internal energy involved and work done during the process. 5+5

(b) Air at 100 kPa and 300 K is compressed steadily to 600 kPa and 500 K . If mass flow rate is 0.02 kg/s, and heat loss of 16 kJ/kg occurs during the process, determine the power requirement of the compressor, assuming that the kinetic and potential energy changes are negligible. Cp = 1.005 kJ/kg.K.

5. (a) A steam turbine operating under steady flow condition, receives 3600 kg/hr of steam.The steam enters the turbine at a velocity of 80 m/s , elevation of 10 m and specific enthalpy of 3276 kJ/kg. It leaves the turbine at a velocity of 150 m/s, elevation of 3m, and specific enthalpy of 2465 kJ/kg. Heat loss to surroundings amounts to 36 MJ/hr. Find out the work output of turbine. 5+5

(b) A closed system whose initial volume is 0.5 m^3 undergoes a non-flow reversible process for which pressure and volume correlation is given by

$$p = 8 - 4V$$

where p is in bar, and V in m^3. If 200 kJ of work is supplied to the system, determine ;

(i) find pressure , and

(ii) find volume.

6. (a) What is PMMI ? Why is it impossible ? What is throttling process ? 5+5

(b) For a steam power plant, following observation were made.

Steam supply condition :	60 bar, 450°C
Condenser pressure :	0.1 bar,
Steam flow rate :	5000 kg/hr

Calculate the following :

(i) Turbine work

(ii) % of pump work compared to turbine work

(iii) Heat addition in the boiler

(iv) Heat rejection in the condenser

(v) Thermal efficiency

7. (a) State and explain the second law of thermodynamics. 5+5

(b) The temperature of the freezer of a domestic refrigerator is maintained at $-16°C$ whereas the ambient temperature is 35°C. If the heat leaks into the freezer at a continuous rate 2 kJ/sec , what is the minimum power required to pump out this heat leakage from freezer, continuously ?

8. (a) Briefly , explain the equivalence of Kelvin - Plank and Clausious statements of second law of thermodynamics. 5+5

(b) The reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 40°C and $-20°C$. The heat transfer to the heat engine is 2000 kJ and the net work output of combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerator and the net heat transfer to the reservoir at 40°C.

9. (a) Steam initially at 2 MPa , 300°C expands in adiabatic and reversible manner in a turbine to 45°C. Determine the ideal work output of turbine in kJ per kg of steam. 5+5

(b) Two reversible heat engines A and B are arranged in series. Engine A rejects heat directly to engine B. Engine A receives 225 kJ at a temperature of 425°C, from the hot source while engine B is in communication with a cold sink at a temperature of 2°C. If the work output of engine A is twice that of B , calculate :

(i) Intermediate temperature between A and B

(ii) Efficiency of each engine

(iii) Heat rejected to the sink.

10. (a) What is entropy ? When entropy is defined only in terms of reversible process, how can then it be evaluated for an irreversible process ? 5+5

(b) A reversible heat engine receives heat from two thermal reservoirs maintained at constant temperatures of 750 K and 500 K. The engine develops 100 kW and rejects 3600 kJ/min of heat to a sink at 250 K. Determine the thermal efficiency of the engine and heat supplied by each thermal reservoir.