No. of Printed Pages : 6

BME-019

BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING)

Term-End Examination 01140

June, 2012

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 - tables is also allowed.*

1. (a) Show that the work (W) in non-flow process for polytropic process $pv^n = C$, is given by **5+5**

$$W = \frac{p_1 v_1 - p_2 v_2}{n - 1}.$$

(b) One mole of an ideal gas at 1.0 MPa and 300 K is heated at constant pressure till the volume is doubled and then it is allowed to expand at constant temperature till the volume is doubled again. Calculate the work done by the gas.

2. (a) Define 'change of state', 'path', and 'process'. What are 'intensive', and 'extensive property' ? **5+5**

(b) If a gas of volume 6000 cm^3, and at pressure of 100 KPa is compressed according to $pv^2 = C$, until the volume becomes 2000 cm^3, determine the final pressure and work transfer.

3. (a) The temperature 't' on a thermometric scale is defined in terms of property 'X' by the relation. 5+5

$$t = a\ lnX + b$$

when 'a' and 'b' are constants.

(b) What is an ideal gas ? What is the difference between universal gas constant and characteristic gas constant.

4. (a) A steam power plant working on Rankine cycle, has a steam supply pressure of 20 bar and condenser pressure of 0.5 bar. If the initial condition of supply system is dry and saturated, calculate the carnot and Rankine efficiency of the cycle. Neglect the pump work. 5+5

(b) 5.0 kg of an ideal gas is compressed adiabatically from pressure 120 kPa and temperature 260 K to a final pressure of 460 kPa.

Find :

(i) work done

(ii) heat added or rejected, and

(iii) change in internal energy

for gas $C_p = 1.00$ KJ/kg-K

$C_v = 0.70$ KJ/kg-K.

5. (a) The work output and heat input for process A are 30 KJ and 15 KJ respectively. Another process B between the same end conditions involves a heat transfer 12 KJ. Determine the change in internal energy involved and work done during process B. Show that if a cycle is formed using process A and B, the given data follows the first law of thermo dynamics. **5+5**

(b) 150 litres of gas at 320 K temperature and 6 bar pressure is contained in a cylinder fitted with a frictionless piston. The piston carries some weight, can move freely and its upper part is exposed to atmosphere. There is an input of paddle work to the gas and its temperature rises to 380 K.

Evaluate :

(i) work done

(ii) ΔU, and ΔH

6. (a) In a cyclic process heat transfers are $+14.2$ KJ, -25.2 KJ, -3.71 KJ and 40.1 KJ. What is the net work for this cyclic process ! **5+5**

(b) (i) What are the various types of energy resources available ? Explain.

(ii) Briefly describe the major functions and duties of an energy manager.

7. (a) Write down the expression for thermal efficiency of heat engine and co-efficient of performance (COP) of heat pump and refrigerator. Briefly describe the working principle of vapour compression refrigeration system with the help of a block diagram. 5+5

(b) The temperature of the freezer of a domestic refrigerator is maintained at $-10°C$ where as the ambient temperature is 30°C. If the heat leaks into the freezer at a continuous rate of 3 KJ/sec, what is the minimum power required to pump out this heat leakage from freezer continuously ?

8. (a) State the clausius and Kelvin - Planck statements being used for second law of thermodynamics. 5+5

(b) A reversible heat engine operates between two reservoirs at temperature of 500°C and 45°C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 45°C and $-15°C$. The heat transfer to the heat engine is 2500 KJ and the net work output of combined engine-refrigerator plant is 400 KJ. Evaluate the heat transfer to the refrigerator and the net heat transfer to the reservoir at 45°C.

9. (a) A steam power cycle operates under the following conditions : 5+5

At inlet of the turbine : $p = 100$ bar, $t = 520°C$

At exit of turbine : $p = 0.3$ bar, $x = 0.9$

At exit of condenser, liquid is dry saturated at $p = 0.3$ bar,

At pump outlet, the pressure is 100 bar.

The mass flow rate of steam is 8 kg/sec; determine :

(i) turbine work

(ii) condenser net loss

(iii) pump work

(iv) Boiler heat input

(b) Two reversible heat engines A and B are arranged in series. Engine A rejects heat directly to engine B. Engine A receives 200 KJ at a temperature of 421°C from the hot source while engine B is in communication with a cold sink at a temperature of 5°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) Show that the entropy change in a process when a perfect gas changes from state 1 to state 2 is given by : 5+5

$$s_2 - s_1 = C_p \, ln\left(\frac{T_2}{T_1}\right) + R \, Ln \left(\frac{P_1}{P_2}\right)$$

(b) A metal block of 5 kg and at 200°C is cooled in a surrounding air which is at 30°C. If the specific heat of metal is 0.4 KJ/Kg-K, calculate the following :

(i) entropy change of block

(ii) entropy change of surrounding and universe.