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ET-201(B)

B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering) B.Tech. (Aerospace Engineering)

Term-End Examination 00803

December, 2011

ET-201(B) : ENGINEERING THERMODYNAMICS

Time : 3 hours *Maximum Marks : 70*

Note : *Answer **any seven** questions. All questions carry **equal** marks. Use of steam tables and scientific calculator is permitted.*

1. (a) What is meant by reversible and irreversible process ? Give two examples of reversible process. State the conditions to be satisfied for a process to be reversible. **5+5**

(b) A barometer reads 76 cm of Hg. What would be the absolute pressure of

(i) a pressure gauge connected to a steam main line to inlet of steam turbine reads 28 bar, and

(ii) a vacuum gauge connected to exhaust line of the same turbine reads equivalent to 910 cm of water column. Express the absolute pressure in both cases in kPa.

2. (a) State and explain Zeroth Law of Thermodynamics. Also name the devices to measure temperature. **5+5**

(b) A mass of gas is compressed in a quasi-static process from 80 kPa, 0.1 m^3 to 0.4 MPa, 0.03m^3. Assuming that the pressure and volume are related by

$pV^n = \text{constant}$,

find the work done by the gas system.

3. (a) Explain the First Law of Thermodynamics as referred to closed systems undergoing a cyclic change. State the limitations of first law of thermodynamics. **5+5**

(b) If a gas of volume 6000 cm^3 and at a pressure of 100 kPa is compressed quasistatically according to

$pV^2 = \text{constant}$

until the volume becomes 2000 cm^3, determine the final pressure and the work transfer.

4. Consider an engine in outer space which operates on the carnot cycle. The only way in which heat can be transferred from the engine is by radiation. The rate at which heat is radiated is proportional to the fourth power of the absolute temperature and to the area of the radiating surface. Show that for a given power output and a given T_1, the area of the radiator will be a minimum, when **10**

$$\frac{T_2}{T_1} = \frac{3}{4}.$$

5. (a) Describe in brief the Kelvin-Planck statement of second law of thermodynamics. 5+5

(b) A domestic food refrigerator maintains a temperature of $-12°C$. The ambient air temperature is 35°C. If heat leaks into the freezer at the continuous rate of 2 kJ/s, determine the least power necessary to pump this heat out continuously.

6. (a) What do you mean by 'Clausius inequality' ? 5+5

(b) Steam at 10 bar and 0.9 dryness fraction is available. Find the final dryness fraction of steam in each of the following two cases.

(i) 170 kJ of heat is removed per kg of steam at constant pressure

(ii) Steam expands isentropically to a pressure 0.5 bar in a turbine in a flow process. The turbine develops 300 kJ of work per kg of steam.

7. (a) Evaluate enthalpy, internal energy, volume and entropy of 1kg of steam having dryness fraction 0.85 and pressure of 20 bar. 5+5

(b) A refrigerating system operates on the reversed carnot cycle. The higher temperature of the refrigerant in the system is 35°C and the lower temperature is $-15°C$. The capacity is to be 12 tonnes. Determine :

(i) Co-efficient of performance.

(ii) Heat rejected from the system per hour.

(iii) Power required.

8. (a) A closed system of constant volume experience a temperature rise of 20° C when a certain process occurs. The heat transfer in the process is 18 kJ. The specific heat at constant volume for the pure substance comprising the system is 1.2 kJ/kg °C, and the system contains 2 kg of this substance. Determine the internal energy and work done. 5+5

(b) A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250° C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy, and the internal energy.

9. (a) Give the comparison between a vapour compression refrigeration system and a vapour absorption refrigeration system. 5+5

(b) A reversed cycle has refrigerating COP of 4,

(i) Determine the ratio T_1/T_2 ; and

(ii) If this cycle is used as heat pump, determine the COP, and heat delivered.

10. (a) What are the sources of energy ? Describe in detail, about wind power generation and its advantage. 5+5

(b) A simple vapour compression plant produces 5 tonnes of refrigeration. The enthalpy values at inlet to compressor, at exit from the compressor, and at exit from the condenser are 183.19 kJ/kg, 209.41 kJ/kg, and 74.59 kJ/kg respectively. Estimate.

(i) The refrigerant flow rate,

(ii) The COP

(iii) The power required to drive the compressor, and

(iv) The rate of heat rejection to the condenser.