

**B.E. DEGREE EXAMINATIONS: NOV/DEC 2010**

Third Semester

**MECHANICAL ENGINEERING**

MEC105: Engineering Thermodynamics

**Time: Three Hours**

**Maximum Marks: 100**

**Answer ALL Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Universal gas constant is equal to  
a) 8.314 kJ/kg K    b) 8314 J/kg K    c) 8.314 kJ/kg mol K    d) 8.314 J/kg mol K
2. For a constant temperature process, pressure and volume relation is  
a) Directly proportional    b) inversely proportional    c) both are equal    d) none of the above
3. COP of a refrigerator is 40% of maximum possible of a reversed Carnot cycle which is working between the temperature limits of 27°C and -13°C. Then COP of the refrigerator is  
a) 2.7    b) 2.8    c) 2.6    d) 2.5
4. Clausius statement of second law of thermodynamics is the basis for the development of  
a) Heat engine    b) Refrigerator    c) compressor    d) thermometer
5. Heat required to change the saturated water into dry steam is.  
a) Sensible heat    b) latent heat    c) specific heat    d) super heat
6. Specific volume of saturated water for all the pressure is  
a) Very large    b) very small    c) approximately zero    d) equal
7. The statement that molecular weights of all gases occupy the same volume at NTP is known as  
a) Dalton's law    b) Avogadro's law    c) Joule's law    d) Charles's law



**PART C (5 x 14 = 70 Marks)**

21. a) (i)  $0.336 \text{ m}^3$  of gas at 10 bar and  $150^\circ\text{C}$  expands adiabatically, until its pressure is 4 bar.

It is then compressed isothermally to its original volume. Find the final temperature and pressure of the gas. Also determine the change in internal energy. Take  $C_p = 1.005 \text{ kJ/kg K}$  and  $C_v = 0.703 \text{ kJ/kg K}$  (7)

(ii) Prove that the heat transfer  $Q = \left[ \frac{\gamma - n}{\gamma - 1} \right] XW$  for a polytropic process (7)

**(OR)**

b) (i) Derive the steady flow energy equation stating the assumptions made (6)

(ii) In an air compressor, air flows steadily at the rate of 15 kg/min. The air enters the compressor at 5 m/s with a pressure of 1 bar and a specific volume of  $0.5 \text{ m}^3/\text{kg}$ . It leaves the compressor at 7.5 m/s with a pressure of 7 bar and specific volume of  $0.15 \text{ m}^3/\text{kg}$ . The internal energy of the air leaving the compressor is 165 kJ/kg greater than that of the air entering. The cooling water in the compressor jackets absorbs heat from the air at the rate of 125 kJ/s. (8)

Find the (1) power required to drive the compressor

(2) ratio of inlet pipe diameter to outlet pipe diameter

22. a) Two reversible heat engines are connected in series. The first engine A receives heat at  $927^\circ\text{C}$  and rejects heat at a constant temperature  $T_2$ . The second engine B receives heat rejected by the engine A, and in turn rejects heat to a reservoir at  $27^\circ\text{C}$ . Calculate the temperature  $T_2$  when i) the efficiency of the engine A is two- third of engine B ii) the work output of engine A is three times than that of engine B.

**(OR)**

b) A reversible heat engine operating between reservoirs at 900 K and 300 K drives a reversible refrigerator operating between reservoirs at 300 K and 250 K. The heat engine receives 1800 kJ heat from 900 K reservoir. The net output from the combined engine refrigerator is 360 kJ. Find the heat transferred to the refrigerator and the net heat rejected to the reservoir at 300 K

23. a) A vessel of volume  $0.04 \text{ m}^3$  contains a mixture of saturated water and steam at a temperature of  $250^\circ \text{ C}$ . The mass of the liquid present is  $9 \text{ kg}$ . Find the pressure, mass, specific volume, enthalpy, entropy and internal energy of the mixture.

**(OR)**

b) A steam turbine receives steam at a pressure of  $20 \text{ bar}$  super heated at  $300^\circ \text{ C}$ . The exhaust pressure is  $0.07 \text{ bar}$  and expansion takes place isentropically. Using steam tables calculate the following 1) Heat supplied assuming that the feed pump supplies water to the boiler at  $20 \text{ bar}$ . 2) Heat rejected 3) Work done.

24. a) Derive the Maxwell's relations from the first principles.

**(OR)**

b) Prove that the difference in specific heat capacity is equal to.

$$C_p - C_v = \frac{TV\beta^2}{K_T}$$

25. a) Air at  $20^\circ \text{ C}$ ,  $40\%$  relative humidity is mixed adiabatically with air at  $40^\circ \text{ C}$ ,  $40\%$  relative humidity in the ratio of  $1 \text{ kg}$  of the former with  $2 \text{ kg}$  of the latter. Find the final condition and psychrometric properties of the mixture.

**(OR)**

b) Explain the following psychrometric terms:

- (i) Wet bulb depression
- (ii) Saturation of air
- (iii) Specific humidity
- (iv) Relative humidity
- (v) Cooling and dehumidification
- (vi) Adiabatic saturation of air
- (vii) Latent heat of air

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