

Register Number:

B.E. DEGREE EXAMINATIONS: NOV/DEC 2012

Third Semester

MEC105: ENGINEERING THERMODYNAMICS

(Common to ME/AUE)

(Use of Steam Tables and Psychrometric Chart are Permitted)

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The general law of expansion and compression is $pv^n = \text{constant}$. The process is said to be hyperbolic, if 'n' is equal to
 - a) 0
 - b) 1
 - c) γ
 - d) ∞
2. Intensive property is independent of
 - a) Volume of the system
 - b) Mass of the system
 - c) Pressure of the system
 - d) Energy of the system
3. Clausius statement of second law thermodynamics is the basis for the development of
 - a) Heat engine
 - b) Compressor
 - c) Refrigerator
 - d) Thermometer
4. The efficiency of reversible engine A and reversible engine B working between same temperature limits have
 - a) Efficiency of A greater than B
 - b) Efficiency of A is equal to B
 - c) Efficiency of A less than B
 - d) None of the above
5. The condition of steam of 2 bar and entropy 6.27 kJ/kg is
 - a) Dry steam
 - b) Wet steam
 - c) Superheated steam
 - d) None of the above
6. In a Rankine cycle with superheated steam
 - a) The work done increases
 - b) The dryness fraction of steam after isentropic expansion increases
 - c) The specific steam consumption decreases
 - d) All of the above
7. Helmholtz function (A) is given by
 - a) $A = U - TS$
 - b) $A = U + TS$
 - c) $A = TS - U$
 - d) $A = U - T/S$
8. TdS equation taking temperature (T) and volume (v) as independent variables is
 - a) $mC_v dT + T(K/\beta)dv$
 - b) $mC_v dT + T\beta K dv$
 - c) $mC_v dT + T(\beta/K)dv$
 - d) $mC_v dT + T\beta dv$

9. The difference between dry bulb temperature and wet bulb temperature
 - a) Dry bulb depression
 - b) Wet bulb depression
 - c) Dew point depression
 - d) Degree of saturation
10. The curved lines on a psychrometric chart indicates
 - a) Dry bulb temperature
 - b) Wet bulb temperature
 - c) Specific humidity
 - d) Relative humidity

PART B (10 x 2 = 20 Marks)

11. Differentiate between intensive and extensive properties.
12. Define point function and path function.
13. State the Kelvin Planck statement of II law of thermodynamics.
14. Give the relationship between COP of heat pump and refrigerator.
15. Find the specific enthalpy of steam at 220KPa.
16. Define specific steam consumption of an ideal Rankine cycle
17. Define Joule Thomson coefficient.
18. Define coefficient of volume expansion and isothermal compressibility
19. Define wet bulb temperature
20. Define apparatus dew point temperature

PART C (5 x 14 = 70 Marks)

21. a) (i) Prove that for a polytrophic process $Q = (\gamma - n / \gamma - 1) \times \text{Work done}$ (4)
- (ii) A system contains 0.15 m^3 of air at 4 bar and 423 K. A reversible adiabatic expansion takes place till the pressure falls to 1 bar. The air is then heated at constant pressure till the enthalpy increases by 67 kJ. Determine the total work done. If the processes are replaced by a single reversible polytrophic process giving the same work between the same initial and final states, determine the index of expansion. Take $C_p = 1.009 \text{ kJ/kg K}$ (10)

(OR)

- b) In an air compressor, air flows steadily at the rate of 15 kg/min. The air enters the compressor at 5m/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 a 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. Find 1. Power required to drive the compressor and 2. Ratio of inlet pipe diameter to outlet pipe diameter

22. a) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and -20°C. The heat transfer to the engine is 2 MJ and the net work output of the combined engine and refrigerator is 360 kJ. Find the heat transfer to the refrigerator and the net heat transfer to the reservoir at 40°C. Also find these values if the efficiency of the heat engine and COP of the refrigerator are each 40% of their maximum possible values.

(OR)

- b) An insulated vessel of capacity 0.056 m³ is divided into two compartments A and B by a conducting diaphragm. Each compartment has a capacity of 0.028 m³. The compartment A contains air at a pressure of 1.5 bar and 25°C and the compartment B contains air at a pressure 4.2 bar and 175°C. Find 1) final equilibrium temperature, 2) final pressure on each side of the diaphragm and 3) change of entropy of the system.

23. a) Steam of dryness fraction 0.96 is expanded in a cylinder according to $PV^{1.02} = \text{constant}$. The pressure at the beginning of expansion is 20 bar, and is continued till the pressure reduces to 1 bar. Determine: 1) the final condition of the steam, 2) the work done during expansion, 3) the change in internal energy, and 4) the heat exchange that occurs between the steam and cylinder walls per kg.

(OR)

- b) Dry saturated steam at 10 bar is supplied to a prime mover and the exhaust takes place at 0.2 bar. Determine the Rankine efficiency, efficiency ratio and specific steam consumption of the prime mover, if the indicated thermal efficiency is 20%. Also find the percentage change in Rankine efficiency, if the steam is initially 90% dry.

24. a) Prove that the difference in specific heat capacities is equal to $C_p - C_v = R$ and $C_p - C_v = TV\beta^2/K_T$

(OR)

- b) Explain the flow process of a real gas through a throttle valve. Derive the expression for Joule Thomson coefficient and deduce its value for an ideal gas.

25. a) A sling psychrometer reads 32°C dry bulb temperature and 26°C wet bulb temperature. Assuming the barometric pressure as 1.0132 bar, determine 1) humidity ratio, 2) relative humidity, 3) dew point temperature, 4) enthalpy, 5) the density of vapour, 6) the degree of saturation

(OR)

- b) (i) 30 m³/min of moist air at 15°C dry bulb temperature and 13°C wet bulb temperature are mixed with 12 m³/min of moist air at 25°C dry bulb temperature and 18°C wet bulb temperature. Determine the dry bulb temperature, wet bulb temperature, specific humidity of the mixture (9)
- (ii) Describe the adiabatic cooling process (5)
