



B.E DEGREE EXAMINATIONS: NOV/DEC 2014

(Regulation 2013)

Third Semester

MECHANICAL ENGINEERING

U13MET301: Engineering Thermodynamics

(Use of approved Steam tables, Mollier chart, Psychrometric chart and compressibility chart is permitted)

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Thermodynamic properties are
 - a) Path function
 - b) point function
 - c) both point and path function
 - d) exact differentials
2. The function of Nozzle is
3. COP of a heat pump is related with refrigerator
 - a) Greater than unity
 - b) less than unity
 - c) Unity
 - d) both are equal
4. The entropy of an isolated system
5. At high pressure, which latent heat is mostly affected?
 - a) Fusion
 - b) Vaporization
 - c) Sublimation
 - d) enthalpy
6. The isentropic efficiency of the turbine is given by
7. Real gases confirm more closely with the
 - a) Dalton's law
 - b) Vander Waals equation
 - c) Avogadro's law
 - d) Redlich kwong equation
8. The locus of all points at which μ_J is zero is the
9. The vapour pressure, during sensible heating of moist air
 - a) increases
 - b) decreases
 - c) can increase or decrease
 - d) remains constant
10. Molecular weight of air is

PART B (10 x 2 = 20 Marks)

(Not more than 40 words)

11. Define Continuum.
12. Give the differential form of the Steady Flow Energy Equation.
13. State Kelvin's and Clausius statements of second law of thermodynamics.
14. Show that entropy is a property of a system.
15. Define latent heat of vaporization.
16. Draw the T-s diagram of an ideal working fluid in a vapour power cycle.
17. State Dalton's law of partial pressure.
18. What is Joule – Thomson coefficient? Why is it zero for an ideal gas?
19. Differentiate Wet bulb and dry bulb temperature.
20. What is sensible heating process?

PART C (5 x 14 = 70 Marks)

(Not more than 400 words)

Q.No. 21 is Compulsory

21. A cyclic steam power plant is to be designed for a steam temperature at turbine inlet of 340°C and an exhaust pressure of 0.07 bar. After isentropic expansion of steam in the turbine, the moisture content at the turbine exhaust is not to exceed 16%. Determine the greatest allowable steam pressure at the turbine inlet, and calculate the rankine cycle efficiency for this steam. Estimate also the mean temperature of heat addition.
22. a) (i) In a steam power plant station, steam flows steadily through a 0.2 m diameter pipeline from the boiler to the turbine. At the boiler end, the steam conditions are found to be: $p = 4 \text{ MPa}$, $t = 400^{\circ}\text{C}$, $h = 3213.6 \text{ kJ/kg}$, and $v = 0.073 \text{ m}^3/\text{kg}$. At the turbine end, the conditions are found to be: $p = 3.5 \text{ MPa}$, $t = 392^{\circ}\text{C}$, $h = 3202.6 \text{ kJ/kg}$. There is a heat loss of 8.5 kJ/kg from the pipeline. Calculate the steam flow rate. (7)
- (ii) A pump forces $1 \text{ m}^3/\text{min}$ of water horizontally from an open well to a closed tank where the pressure is 0.9 MPa . Compute the work the pump must do upon the water in an hour just to force the water into the tank against the pressure. Sketch the system upon which the work is done before and after the process. (7)

(OR)

- b) (i) A reciprocating air compressor takes in $2 \text{ m}^3/\text{min}$ at 0.11 MPa , 20°C which it delivers at 1.5 MPa , 111°C to an aftercooler where the air is cooled at constant pressure to 25°C . The power absorbed by the compressor is 4.15 kW . Determine the heat transfer in a) the compressor b) the cooler. State your assumptions (7)
- (ii) A piston and cylinder machine containing a fluid system has a stirring device in the cylinder. The piston is frictionless, and it is held Down against the fluid due to the atmospheric pressure of 101.325 kPa . The stirring device is turned $10,000$ revolutions with an average torque against the fluid of 1.275 mN . Meanwhile the piston of 0.6 m diameter moves out 0.8 m . Find the net work transfer for the system. (7)

23. a) (i) A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4 . Evaluate the ratio of heat transfer to the circulating water to the heat transfer to the heat engine. (10)
- (ii) Elaborate the principle of increase of entropy (4)

(OR)

- b) (i) A refrigeration plant for a food store operates as a reversed Carnot heat engine cycle. The store is to be maintained at a temperature of -5°C and the heat transfer from the store to the cycle is at the rate of 5 kW . If heat is transferred from the cycle to the atmosphere at a temperature of 25°C , Calculate the power required to drive the plant. (10)
- (ii) An ideal gas is flowing through an insulated pipe at the rate of 3 kg/s . There is a 10% pressure drop from inlet to exit of the pipe. What is the rate of exergy loss because of pressure drop due to friction? Take $R = 0.287 \text{ kJ/kg K}$ and $T_o = 300 \text{ K}$ (4)

24. a) A vessel contains 8 kg of O_2 , 7 kg of N_2 and 22 kg of CO_2 . The total pressure in the vessel is 400 kPa the temperature is 100°C . Calculate (a) the partial pressure of each gas in the vessel (b) the volume of vessel and (c) the total pressure in the vessel when the temperature is raised to 200°C .

(OR)

b) State and derive the Maxwell relations. Explain their importance in thermodynamics

25. a) (i) Two streams of air 25°C , 50% RH and 25°C , 60%RH are mixed adiabatically to obtain 0.3 kg/s of dry air at 30°C . Calculate the amounts of air drawn from both streams and the humidity ratio of the mixed air. (7)

(ii) A Sling psychrometer reads 40°C DBT and 36°C WBT. Find the humidity ratio, relative humidity, dew point temperature, specific volume and enthalpy of air. (7)

(OR)

b) (i) Air at 20°C , 40% RH is mixed adiabatically with air at 40°C , 40% RH in the ratio of 1 kg of the former with 2 kg of the latter (on dry basis). Find the final condition of air. (7)

(ii) Saturated air at 2°C is required to be supplied to a room where the temperature must be held at 20°C with a relative humidity of 50%. The air is heated and then water at 10°C is sprayed in to give the required relative humidity. Determine the temperature to which the air must be heated and the mass of spray water required per m^3 of air at room conditions. Assume that the total pressure is constant at 1.013 bar and neglect fan power (7)
