Reg. No. : | | | | | | | | | | |

Question Paper Code: 31073

B.E. / B.Tech. DEGREE EXAMINATION, APRIL 2015.

Third Semester

Mechanical Engineering

01UME 303 – ENGINEERING THERMODYNAMICS

(Regulation 2013)

Duration: Three hours Maximum: 100 Marks

(Standard Steam Tables and Psychrometric Charts are permitted)

Answer ALL Questions.

PART A - (10 x 2 = 20 Marks)

1. What is the convention for positive and negative work?
2. What is PMM1? Why is it impossible?
3. What do you mean by “Clausius Inequality”?
4. State Kelvin-Planck statement of the second law of thermodynamics.
5. If water is at 65°C at 1 atm, What is the state of water? What is its specific enthalpy?
6. Name the different processes of Rankine cycle on T-S diagram.
7. State Gibbs function.
8. State the assumptions made in kinetic theory of gases?
9. State Dalton’s law of partial pressure.
10. Define DPT and degree of saturation.

PART - B (5 x 16 = 80 Marks)

11. (a) 1 *kg* of gas at 1.1 bar, 27°*C* is compressed to 6.6 bar as per the law $pv^{1.3}$=constant. Calculate work and heat transfer, if

(i) When the gas is ethane (C_2H_6) with molar mass of 30 *kg/ k* mol and C_p of 2.1 *kJ/kgK* (8)

(ii) When the gas is argon (*Ar*) with molar mass of 40 *kg/ k* mol and C_p of 0.52 *kJ/kgK* (8)

Or

(b) In an isentropic flow through nozzle, air flows at the rate of 600 *kg/hr*. At inlet to the nozzle, pressure is 2 *MPa* and temperature is 127°*C*. The exit pressure is 0.5 *MPa*. Initial air velocity is 300 *m/s*. Determine (i) Exit velocity of air (ii) Inlet and exit area of nozzle. (16)

12. (a) Two reversible heat engines *A* and *B* are arranged in series. Engine *A* rejecting heat directly to engine *B*, receives 200*kJ* at a temperature of 421°*C* from a hot source, while engine *B* is in communication with a cold sink at a temperature of 4.4°*C*. If the work output of *A* is twice that of *B*, find (i) The intermediate temperature between *A* and *B* (ii) the efficiency of each engine (iii) The heat rejected to the cold sink. (16)

Or

(b) A house hold refrigerator is maintained at a temperature of 275 *K*. Every time the door is opened, warm material is placed inside, introducing an average of 420 *kJ*, but making only a small change in the temperature of the refrigerator. The door is opened 20 times a day, and the refrigerator operates at 15% of the ideal COP. The cost of work is Rs.2.50 per *kWhr*. What is the bill for the month of April for this refrigerator? The atmosphere is at 303 *K*. (16)

13. (a) A cyclic steam power plant is to be designed for a steam temperature at turbine inlet of 633*K* and an exhaust pressure of 8*kPa*. After isentropic expansion of steam in the turbine, the moisture content at the turbine exhaust is not to exceed 15%. Determine the greatest allowable steam pressure at the turbine inlet, and calculate the Rankine cycle efficiency for these steam conditions. Estimate also the mean temperature of heat addition. (16)

Or

(b) A rigid tank of $0.03m^3$ capacity contains wet vapour at $80kPa$. If the wet vapour mass is 12 *kg*, calculate the heat added and the quality of the mixture when the pressure inside the tank reaches 7 *MPa*. (16)

14. (a) Explain and derive the (i) Joule-Thomson co-efficient (ii) Clausius Clapeyron equation. (16)

Or

(b) (i) Derive Maxwell's equations. (10)

(ii) Prove $Tds = C_v\,dT + T(\partial p/\partial T)_v\,dV$. (6)

15. (a) Atmospheric air at 1.0132 bar has a DBT of 32°*C* and a WBT of 26°*C*. Compute (i) The partial pressure of water vapour, (ii) The specific humidity, (iii) The dew point temperature, (iv) The relative humidity, (v) The degree of saturation, (vi) The density of air in the mixture, (vii) The density of water vapour in the mixture and (viii) The enthalpy of the mixture. (16)

Or

(b) (i) Air at 20°*C*, 40% relative humidity is mixed adiabatically with air at 40°*C*, 40% RH in the ratio of 1*kg* of former with 2*kg* of latter(on dry basis). Find the final condition (humidity and enthalpy) of air. (8)

(ii) A steam of air at 101.32*kPa*, 18°*C*, and a relative humidity of 30% is flowing at the rate of 14.15 m^3/min. A second stream at 101.32*kPa*, 38°*C* and a relative humidity of 50% is flowing at the rate of 8.5 m^3/min. The two streams are mixed adiabatically to form a third stream at 101.31*kPa*. Determine the specific humidity, the relative humidity and the temperature of the third stream. (8)