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Question Paper Code : 20804

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Third Semester

Mechanical Engineering

ME 6301 — ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering / Mechanical and Automation Engineering)

(Also common to PTME 6301 – Engineering Thermodynamics for B.E. (Part-Time) Second Semester – Mechanical Engineering Regulations – 2014)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between path functions and point functions.

2. What is the work transfer in free expansion process? And why?

3. Compare source with sink.

4. What happens to energy, entropy and energy of an isolated system? and why?

5. What is degree of superheat?

6. What is Carnot vapour cycle? Plot the same on T-s diagram.

7. Define compressibility factor.

8. What is the significance of Clasius-Clapeyron equation?

9. State Dalton's law of partial pressure.

10. What is meant by degree of saturation? List the limiting values.

PART B — (5 × 13 = 65 marks)

11. (a) 5 kg of air at 100 kPa pressure and 333 K temperature is compressed polytropically to pressure 750 kPa as per the law $Pv^{1.3}$. It is then cooled at constant pressure to 333 K. It is then cooled at constant temperature to its original condition. Plot the cycle on p-v diagram, calculate the work in each process and network and heat transfer.

Or

(b) A compressor delivers 720 kg of air per hour. Air enters at a velocity of 12 m/s, pressure of 1 bar and specific volume of 0.5 m^3/kg, leaves at a velocity of 90 m/s, pressure of 8 bar and specific volume of 0.14 m^3/kg. The increase in enthalpy of air passing through the air compressor is 150 kJ/kg and heat loss to the surroundings is 12 kJ/s. Find: (i) power required to drive the compressor; (ii) ratio of inlet to outlet pipe diameter.

12. (a) If three Carnot engines of same efficiency connected in series such that the 1200 K reservoir supplies 2400 kJ of heat and 150 K reservoir receives 300 kJ of heat, find out the intermediate temperatures, the efficiency and the work output of all the engines.

Or

(b) Air flows through an adiabatic compressor at 2 kg/s. The inlet conditions are 100 kPa and 310 K and the exit conditions are 700 kPa and 560 K. Consider T_0 to be 298 K. Determine the change in availability and the irreversibility.

13. (a) A cylinder with piston contains steam at 8 bar and 435°C. If it is cooled to 200°C at constant pressure, calculate the heat and work transfer per kg and their directions.

Or

(b) In a reheat Rankine cycle, steam enters the steam turbine at 30 bar and 400°C and expands in a high pressure steam turbine to an intermediate pressure of 3 bar at which it is reheated to 400°C before entering the low pressure turbine. The condenser pressure is 0.5 bar. If the mass flow rate of steam is 40 kg/s. calculate the specific steam consumption, the net work per kg, the power output and the thermal efficiency.

14. (a) 5 kmol of carbon monoxide is stored in a 1.135 m^3 container at 215 K. Determine the pressure using (i) ideal gas equation and (ii) van der Waals equation. The constants in the van der Waals equation are 146.3 $kPa.m^6/kmol^2$ and 0.0394 $m^3/kmol$.

Or

(b) Derive the four Maxwell's relations.

15. (a) Atmospheric air at 101.325 kPa and 288.15 K contains 21% oxygen and 79% nitrogen by volume. Calculate the (i) mole fractions and partial pressures of oxygen and nitrogen and (ii) molar mass, gas constant and density of the air. Take molar mass of oxygen and nitrogen as 32 and 28 kg/kmol.

Or

(b) If the air flow of 1800 m^3/h at 35°C and RH of 50% is mixed with another air stream of 2100 m^3/h of air whose both dry and wet temperatures are 20°C. If the pressure is constant at 1 atm, calculate (i) the dry bulb temperature (ii) the relative humidity (iii) the specific humidity (iv) the volume flow rate of the mixture.

PART C — (1 × 15 = 15 marks)

16. (a) An adiabatic air compressor is to be powered by a direct-coupled adiabatic steam turbine that is also driving a generator. Steam enters the turbine at 12.5 MPa and 500°C at a rate of 25 kg/s and exits at 10 kPa and a quality of 0.92. Air enters the compressor at 98 kPa and 295 K at a rate of 10 kg/s and exits at 1 MPa and 620 K. Determine the net power delivered to the generator by the turbine.

Or

(b) During an experiment conducted in a room at 25°C, a laboratory assistant measures that a refrigerator that draws 2 kW of power has removed 30,000 kJ of heat from the refrigerated space, which is maintained at –30°C. The running time of the refrigerator during the experiment was 20 min. Determine if these measurements are reasonable.

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