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Question Paper Code : 11403

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2011

Third Semester

Mechanical Engineering

ME 2202 — ENGINEERING THERMODYNAMICS

(Regulation 2008)

(Common to PTME 2202 Engineering Thermodynamics for B.E (Part-Time) Mechanical Engineering Third Semester - Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions

PART A — ($10 \times 2 = 20$ marks)

1. Calculate the actual pressure of air in the tank if the pressure of compressed air measured by manometer is 30 cm of mercury and atmospheric pressure is 101 kPa. (Take g = 9.78 m/s^2)

2. What is meant by 'Hyperbolic Process'?

3. List out the generic types of irreversibilities.

4. State : Carnot Theorem and Its Corollaries.

5. What do you understand from the word 'Dryness fraction'?

6. What are the ways by which Rankine cycle efficiency may be improved?

7. State : Dalton's law of partial pressures.

8. What do you mean by "Compressibility factor"?

9. Define : Relative humidity.

10. What do you understand from the "Dew point temperature"?

PART B — (5 × 16 = 80 marks)

11. (a) A gas contained in a cylinder is compressed from 1 MPa and 0.05 m^3 to

2 MPa. Compression is governed by $PV^{1.4}$ constant. Internal energy of gas is given by; $U = 7.5\ PV - 425$, kJ. where P is pressure in kPa and V is volume in m^3. Determine heat, work and change in internal energy assuming compression process to be quasistatic. Also find out work interaction, if the 180 kJ of heat is transferred to system between same states.

Also explain why it is different from above? (16)

Or

(b) In a gas turbine installation air is heated inside heat exchanger up to $750\ ^{\circ}C$ from ambient temperature of $27\ ^{\circ}C$. Hot air then enters into gas turbine with the velocity of 50 m/s and leaves at $600\ ^{\circ}C$. Air leaving turbine enters a nozzle at 60 m/s velocity and leaves nozzle at temperature of $500\ ^{\circ}C$ For unit mass flow rate of air determine the following assuming adiabatic expansion in turbine and nozzle, (16)

(i) Heat transfer to air in heat exchanger

(ii) Power output from turbine

(iii) Velocity at exit of nozzle.

Take up for air as 1.005 kJ/kg° K.

12. (a) A reversible heat engine operates between two reservoirs at $827\ ^{\circ}C$ and $27\ ^{\circ}C$. Engine drives a Carnot refrigerator maintaining $-13\ ^{\circ}C$ and rejecting heat to reservoir at $27\ ^{\circ}C$. Heat input to the engine is 2000 kJ and the net work available is 300 kJ. How much heat is transferred to refrigerant and total heat rejected to reservoir at $27\ ^{\circ}C$? (16)

Or

(b) (i) How do you differentiate the Exergy (Availability) and energy based upon their characteristics? (4)

(ii) Determine the rate of power loss due to irreversibility in a heat engine operating between temperatures of 1800 K and 300 K. Engine delivers 2 MW of power when heat is added at the rate of 5 MW. (12)

13. (a) In a closed vessel the 100 kg of steam at 100 kPa, 0.5 dry is to be brought to a pressure of 1000 kPa inside vessel. Determine the mass of dry saturated steam admitted at 2000 kPa for raising pressure. Also determine the final quality. (16)

Or

(b) A steam power plant running on Rankine cycle has steam entering HP turbine at 20 MPa, $500\,^{o}C$ and leaving LP turbine at 90% dryness. Considering condenser pressure of 0.005 MPa and reheating occurring up to the temperature of $500\,^{o}C$ determine, (16)

(i) The pressure at which steam leaves HP turbine

(ii) The thermal efficiency.

(iii) Work done.

14. (a) In 5 kg mixture of gases at 1.013 bar and 300 K the various constituent gases are as follows, 80% N2, 18% O_2, 2% CO_2. Determine the specific heat at constant pressure, gas constant for the constituents and mixture and also molar mass of mixture taking $\gamma = 1.4$ for N_2 and O_2 and $\gamma = 1.3$ for CO_2. Universal gas constant = 8314 J/kg.K . (16)

Or

(b) Derive the Clausius Clapeyron equations and Vander Waal's equations. (16)

15. (a) For the atmospheric air at room temperature of $30\,^{o}C$ and relative humidity of 60% determine partial pressure of air, humidity ratio, dew point temperature, density and enthalpy of air. (16)

Or

(b) Two streams of moist air, one having flow rate of 3 kg/s at $30\,^{o}C$ and 30% relative humidity, other having flow rate of 2 kg/s at $35\,^{o}C$ and 85% relative humidity get mixed adiabatically. Determine specific humidity and partial pressure of water vapour after mixing. Take C_P, Stream = 1.86 kJ/kg.K. (16)

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