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

Question Paper Code : T3050

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009

Third Semester

Mechanical Engineering

ME 2202 — ENGINEERING THERMODYNAMICS

(Regulation 2008)

Time : Three hours Maximum : 100 Marks

(Use of Standard Thermodynamic tables, Mollier diagram, Psychrometric chart and Refrigerant tables are permitted)

Answer ALL Questions

PART A — (10 × 2 = 20 Marks)

1. What is the difference between the classical and the statistical approaches to thermodynamics?

2. State the zeroth law of thermodynamics.

3. What is the Kelvin-Planck expression of the second law of thermodynamics?

4. Why is the second law, called a directional law of nature?

5. Why is excessive moisture in steam undesirable in steam turbines?

6. Why is the Carnot cycle not a realistic model for steam power plants?

7. What does the Joule-Thomson coefficient represent?

8. In a gas mixture, which component will have the higher partial pressure-the one with the higher mole number or the one with the larger molar mass?

9. What is the difference between dry air and atmospheric air?

10. When are the dry-bulb and dew-point temperatures identical?

PART B — (5 × 16 = 80 Marks)

11. (a) A reciprocating air compressor takes in 2 m^3/min air at 0.11 MPa, 293 K which it delivers at 1.5 MPa, 384 K to an after cooler where the air is cooled at constant pressure to 298 K. The power absorbed by the compressor is 4.15 kW. Determine the heat transfer in (i) the compressor (ii) the cooler. State your assumptions. (16)

Or

(b) In a turbo machine handling an incompressible fluid with a density of 1000 kg/m^3 the conditions of the fluid at the rotor entry and exit are as given below :

	Inlet	Exit
Pressure	1 .15 MPa	0.05 MPa
Velocity	30 m/sec	15.5 m/sec
Height above datum	10 m	2 m

If the volume flow rate of the fluid is 40 m^3/s, estimate the net energy transfer from the fluid as work. (16)

12. (a) The interior lighting of refrigerators is provided by incandescent lamps whose switches are actuated by the opening of the refrigerator door. Consider a refrigerator whose 40W light bulb remains on continuously as a result of a malfunction of the switch. If the refrigerator has a coefficient of performance of 1.3 and the cost of electricity is Rs. 8 per kWh, determine the increase in the energy consumption of the refrigerator and its cost per year if the switch is not fixed. (16)

Or

(b) (i) A Carnot heat engine receives 650 kJ of heat from a source of unknown temperature and rejects 250 kJ of it to a sink at 297 K. Determine the temperature of the source and the thermal efficiency of the heat engine. (6)

(ii) A Carnot heat engine receives heat from a reservoir at 1173 K at a rate of 800 kJ/min and rejects the waste heat to the ambient air at 300 K. The entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at 268 K and transfers it to the same ambient air at 300 K. Determine the maximum rate of heat removal from the refrigerated space and the total rate of heat rejection to the ambient air. (10)

13. (a) Consider a steam power plant operating on the ideal Rankine cycle. Steam enters the turbine at 3 MPa and 623 K and is condensed in the condenser at a pressure of 10 kPa. Determine (i) the thermal efficiency of this power plant, (ii) the thermal efficiency if steam is superheated to 873 K instead of 623 K, and (iii) the thermal efficiency if the boiler pressure is raised to 15 MPa while the turbine inlet temperature is maintained at 873 K. (16)

Or

(b) Consider a steam power plant operating on the ideal reheat Rankine cycle. Steam enters the high-pressure turbine at 15 MPa and 873 K and is condensed in the condenser at a pressure of 10 kPa. If the moisture content of the steam at the exit of the low-pressure turbine is not to exceed 10.4 percent, determine (i) the pressure at which the steam should be reheated and (ii) the thermal efficiency of the cycle. Assume the steam is reheated to the inlet temperature of the high-pressure turbine. (16)

14. (a) (i) Using the Clapeyron equation, estimate the value of the enthalpy of vaporization of refrigerant R –134a at 293 K, and compare it with the tabulated value. (10)

(ii) Show that $c_p - c_v = R$ for an ideal gas. (6)

Or

(b) (i) Show that the Joule-Thomson coefficient of an ideal gas is zero. (6)

(ii) Using the cyclic relation and the first Maxwell relation, derive the other three Maxwell relations. (10)

15. (a) (i) What is the lowest temperature that air can attain in an evaporative cooler if it enters at 1 atm, 302 K, and 40 percent relative humidity? (4)

(ii) Consider a room that contains air at 1 atm, 308 K. and 40 percent relative humidity. Using the psychrometric chart, determine: the specific humidity, the enthalpy, the wet-bulb temperature, the dew-point temperature and the specific volume of the air. (12)

Or

(b) An air-conditioning system is to take in outdoor air at 283 K and 30 percent relative humidity at a steady rate of 45 m^3/min and to condition it to 298 K and 60 percent relative humidity. The outdoor air is first heated to 295 K in the heating section and then humidified by the injection of hot steam in the humidifying section. Assuming the entire process takes place at a pressure of 100 kPa, determine (i) the rate of heat supply in the heating section and (ii) the mass flow rate of the steam required in the humidifying section.

———————