BACHELOR OF ENGINEERING IN PRODUCTION ENGG. EXAMINATION, 2019
(1st Year, 2nd Semester Supplementary)

THERMODYNAMICS

Time: Three Hours **Full Marks: 100**

All parts of a question (*a, b, c* etc) should be answered at one place.
Assume any missing data with proper justification.
Answer **FIVE** questions.

1.(a) What is a thermodynamic system? Mention the various types of thermodynamic system with suitable examples.

(b) What is 'quasistatic process?

(c) State the Zeroth law of thermodynamics.

(d) The initial volume of a closed system is 0.2 m^3. The initial pressure and temperature are 50 kPa and 90° C respectively. The air is compressed to a final volume of 0.02 m^3 and the final pressure became 2000 kPa. Estimate the work transfer and heat transfer during the process. Take R= 0.287 kJ/kg-K and C_v= 0.718 kJ/kg-K for air.

(2+3)+3+2+10=20

2.(a) Mention the difference between steady flow and unsteady flow systems.

(b) Explain that PMM-I is impossible to construct.

(c) A system is a steady flow nozzle ideally insulated so that no heat transfer takes place with the surroundings while the flow takes place though it. A gas expands through the nozzle following a reversible polytropic law $pv^{1.3}=C$. There is no change in the potential energy but the pressure drops from 15 bar to 1.5 bar and the specific volume increases from 0.1 m^3 to 0.6 m^3. If the entrance velocity to nozzle is 79 m/s determine the exit velocity. Deduce an expression of SFEE you have used.

4+5+11=20

3.(a) State the third law of thermodynamics.

(b) Show that Clausius statement and Kelvin-Plank Statement are two corollaries of second law of thermodynamics.

(c) It is desired to produce a temperature of -35° C by refrigeration. High temperature heat reservoir and surroundings are at 210° C and 35° C respectively. Work is obtained from a heat engine operating between source and the surroundings and used to drive the refrigerator. Determine the ratio of heat transferred from the high temperature reservoir to the heat transferred from the cold chamber assuming that the Carnot cycle is used for both heat engine and refrigeration.

2+8+10=20

4.(a) State and prove the Clausius Inequality.

(b) Show that the entropy change between states 1 and 2 in a polytropic process $pv^n = C$ is given by $s_2 - s_1 = \left(\frac{\gamma - n}{1 - n}\right) c_v \ln\left(\frac{T_2}{T_1}\right)$

(c) Two identical finite bodies of constant heat capacity (C_p= 8.4 kJ/K) are initially at temperatures 500° C and 30° C respectively. If a heat engine is operated in cycle between these two bodies calculate the maximum work obtained from the engine by using the entropy principle. Deduce an expression for maximum work you have obtained.

8+5+7=20

[Turn over

5.(a) What are the assumptions made for Air standard cycle?

(b) Compare the thermal efficiencies of Otto, Diesel and Dual cycles for the same maximum pressure and temperature and the same heat rejection.

(c) An ideal Otto cycle has a compression ratio of 8. The minimum and maximum temperatures of the cycle are 27° C and 1327° C respectively. The pressure of air at the beginning of compression process is 100 kPa. Determine the power developed and mean effective pressure for Otto cycle if mass flow rate is 1200 kg/h. Assume c_p and c_v values as 1.005 kJ/kg-K and 0.718 kJ/kg-K respectively.

5+5+10=20

6.(a) Show that entropy is a property of system.

(b) Prove that PMM II is impossible to construct.

(c) How can you predict that whether a process is reversible or irreversible?

(d) With the help of entropy principle shows that the mixing of two non-reactive fluids is an irreversible process.

(e) Show that entropy is a property of system.

5+5+3+7=20

7.(a) Explain the following terms:
(i) Relative humidity, (ii) Psychometric chart, (iii) Dew point temperature, (iv) wet bulb temperature, (v) psychrometric chart

(b) What do you understand by Exergy and Anergy?

(c) Show that there is a decrease in available energy when heat is transferred through a finite temperature difference.

10+5+5=20

8.(a) What do you mean by the following terms?

(i) Critical point, (ii) Superheated steam.

(b) Discuss briefly the working principle of Vapour absorption refrigeration cycle with the help of flow diagram and ***T-s*** diagram.

(c) In an R-12 refrigeration machine the compressor has the saturated suction temperature of 5° C and discharge temperature of 45°C. The enthalpy of the refrigerant at the end of compression is 372.3 kJ/kg. Draw the cycle diagram on the ***p-h*** plane. Determine (i) the coefficient of performance of the cycle and (ii) the mass flow rate of refrigerant per tonne of refrigeration. Neglect the sub-cooling of liquid refrigerant. The refrigerant property table is given below as:

Temp (° C)	Pressure (bar)	Sp. volume of vapour (m^3/kg)	Sp. enthalpy (kJ/kg)		Sp. entropy (kJ/kg-K)	
			h_f	h_g	s_f	s_g
5	3.6375	0.04799	204.68	354.885	1.01685	1.5569
40	9.5909	0.01837	239.03	368.81	1.1315	1.5459

4+8+8=20