Reg. No.												

Question Paper Code	11693

B.E./B.Tech. - DEGREE EXAMINATIONS, NOV/DEC 2022

Third Semester

Mechanical Engineering

(Common to Mechanical and Automation Engineering)

20MEPC302 - ENGINEERING THERMODYNAMICS

(Regulation 2020)

(Use of Psychometric chart and Steam tables are permitted)

Duration: 3 Hours

Max. Marks: 100

PART - A (10 × 2 = 20 Marks)

Answer ALL Questions

		Marks, K-Level,CO
1.	What are the classical / macroscopic approaches in thermodynamics?	*2,K1,CO1*
2.	Show that energy of an isolated system is always constant.	*2,K1,CO1*
3.	An inventor claims to have developed an engine which absorbs 100 kW of heat from a reservoir at 1000 K produces 60 kW of work and rejects heat to a reservoir at 500 K. Will you advise investment in its development?	*2,K2,CO2*
4.	What is the difference between a heat pump and a refrigerator?	*2,K2,CO2*
5.	Define a pure substance. Give examples.	*2,K1,CO3*
6.	List the advantages of Reheating of steam.	*2,K1,CO3*
7.	Define Avogadro's law.	*2,K1,CO4*
8.	Write the Clausius-Clapeyron equation and label all the variables.	*2,K1,CO4*
9.	Explain Dalton's law of partial pressure.	*2,K1,CO5*
10.	How does the wet bulb temperature differ from the dry bulb temperature?	*2,K1,CO5*

PART - B (5 × 13 = 65 Marks)

Answer ALL Questions

11. a) The values of internal energy at all end states if initial value is 105 kJ. A fluid system, contained in a piston and cylinder machine, passes through a complete cycle of four processes. The sum of all heat transferred during a cycle is -340 kJ. The system completes 200 cycles per min. *13,K2,CO1*

Process	Q (kJ/min)	W (kJ/min)	E (kJ/min)
1-2	0	4340	–
2-3	42,000	0	–
3-4	-4,200	0	-73,200
4-1	-	-	-

Complete the above table showing the method for each item, and compute the net rate of work output in kW.

OR

b) Air is compressed from 100 kPa and 22°C to a pressure of 1 MPa while being cooled at the rate of 16 kJ/kg by circulating water through the compressor casing. The volume flow rate of air at inlet Condition is 150 m^3/min and power input to compressor is 500 kW. Neglecting the gravitational potential energy, determine the mass flow rate and the temperature of air at exit. *13,K2,CO1*

12. a) A Carnot heat engine works between two temperatures of source at 900 K and sink at 300 K. It operates a Carnot refrigerator working between two temperatures of 300 K and 250 K. The heat engine is supplied with 50 kJ/s and it not only operates refrigerator, but also delivers a net power of 10 kW. Determine the heat transferred to the refrigerant in the refrigerator and the net heat transfer to the sink maintained at 300 K. *13,K2,CO2*

OR

b) One kg of ice at -5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere. a. Determine the entropy increase of the universe. b. What is the minimum amount of work necessary to convert the water back into ice at -15°C? Where Cp of the ice is 2.093 kJ/kg K and latent heat fusion of ice is 333.3 kJ/kg. *13,K2,CO2*

13. a) Define the following terms pertaining to pure substances like water: i)Sensible heating, ii)Latent heating, iii)Saturation states, iv)Saturation pressure, v)Saturation temperature, vi)Triple point, vii)Dryness fraction, viii)Superheated steam and Degree of super heat. *13,K1,CO3*

OR

b) Steam at 50 bar, 400 °C expands in a Rankine cycle to 0.34 bar. For a mass flow rate of 150 kg/sec of steam, determine i) Power developed, ii) Thermal efficiency, iii) Specific steam consumption. *13,K2,CO3*

14. a) Derive Maxwell relations. *13,K2,CO4*

OR

b) Determine the pressure of nitrogen gas at T=175K and V=0.00375 m^3/kg on the basis of (i) The ideal gas equation of state, (ii) The van der waals equation of state. The van der waals constant for nitrogen are α=0.175 m^6 kPa/kg^2, b=0.00138 m^3/kg. *13,K2,CO4*

15. a) A mixture of ideal gases consists of 4 kg of nitrogen and 6 kg of carbon dioxide at a pressure of 4 bar and a temperature of 20°C. Find: a) Mole fraction of each constituent, b) The equivalent molecular weight of the mixture, c) Equivalent gas constant of the mixture, d) Partial pressures and partial volumes, e) Volume and density of the mixture, and f) Cp and Cv of the mixture. *13,K2,CO5*

OR

b) A sling psychrometer in a laboratory test recorded the following readings: Dry bulb temperature = 35°C Wet bulb temperature = 25°C Calculate the following: (1) Specific humidity (2) Relative humidity (3) Vapour density in air (4) Dew point temperature (5) Enthalpy of mixture per kg of dry. Take atmospheric pressure = 1.0132 bar. *13,K2,CO5*

PART - C (1 × 15 = 15 Marks)

16. a) A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150bar, 550 °C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser at 0.1 bar. Draw T-s and h-s diagram. Find (i) Quality of steam at turbine exhaust (ii) Cycle efficiency (iii) Steam Rate in kg/kWh. *15,K2,CO3*

OR

b) It is required to design an air-conditioning plant for a small office room *15,K2,CO5*

Outdoor conditions - 14°C DBT and 10°C WBT
Required conditions - 20°C DBT and 60% R.H.
Amount of air circulation - 0.30 m^3/min./person
Seating capacity of office - 60
The required condition is achieved first by heating and then by adiabatic humidifying.
Determine the following: (a) Heating capacity of the coil in kW and surface temperature required if the by pass factor of coil is 0.4. (b) The capacity of the humidifier. Solve the problem by using psychrometric chart.