Reg. No.																

Question Paper Code	13087

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Third Semester

Mechanical Engineering

(Common to Mechanical and Automation Engineering)

20MEPC302 - ENGINEERING THERMODYNAMICS

Regulations - 2020

(Use of Steam tables Mollier Diagram Refrigeration tables and Psychrometric Chart is permitted)

Duration: 3 Hours Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	Which property depends on the amount of matter in a system? (a) Intensive property (b) Extensive property (c) Point function (d) Path function	1	K2	CO1
2.	A closed system: (a) Can exchange both mass and energy with the surroundings (b) Can exchange only mass with the surroundings (c) Can exchange only energy with the surroundings (d) Cannot exchange either mass or energy	1	K2	CO1
3.	A process that takes place in such a way that the system remains infinitesimally close to an equilibrium state is called: (a) Irreversible process (b) Quasi-static process (c) Cyclic process (d) Adiabatic process	1	K2	CO1
4.	In unsteady-state flow processes: (a) Properties change with time (b) Properties do not change with time (c) Mass in the system changes (d) Energy in the system changes	1	K1	CO1
5.	Which of the following devices operates in reverse to a heat engine? (a) Heat pump (b) Boiler (c) Turbine (d) None of the above	1	K1	CO2
6.	The Carnot cycle consists of: (a) Two isothermal processes and two isobaric processes (b) Two adiabatic processes and two isobaric processes (c) Two isothermal processes and two adiabatic processes (d) Two isochoric processes and two isobaric processes	1	K1	CO2
7.	Clausius inequality is a mathematical expression of: (a) First Law of Thermodynamics (b) Second Law of Thermodynamics (c) Zeroth Law of Thermodynamics (d) Conservation of mass	1	K2	CO2
8.	The principle of increase in entropy implies: (a) The entropy of the universe remains constant (b) The entropy of the universe increases for any real process (c) The entropy of the system always decreases (d) Work output always decreases	1	K2	CO2
9.	Which of the following phases of water exists at the critical point? (a) Only liquid (b) Only vapor (c) Both liquid and vapor (d) Neither liquid nor vapor	1	K1	CO3
10.	In the Rankine cycle, which process converts heat into work? (a) Isentropic expansion in the turbine (b) Isobaric heat addition in the boiler (c) Isothermal compression in the pump (d) Adiabatic compression in the condenser	1	K2	CO3
11.	The actual Rankine cycle differs from the ideal Rankine cycle due to: (a) Heat losses and frictional losses (b) Isentropic processes (c) Constant pressure heat addition (d) Perfect insulation of all components	1	K2	CO3

12.	The efficiency of the Rankine cycle can be improved by: (a) Reducing the boiler pressure (b) Superheating the steam (c) Increasing the condenser temperature +-(d) Decreasing the turbine work output	1	K2	CO3
13.	A real gas behaves like an ideal gas at: (a) High pressure and low temperature (b) Low pressure and high temperature (c) Low pressure and low temperature (d) High pressure and high temperature	1	K2	CO4
14.	The van der Waals equation is used for: (a) Ideal gases (b) Real gases (c) Perfect gases (d) Monoatomic gases	1	K1	CO4
15.	The Maxwell relations are derived from which thermodynamic potential? (a) Internal energy (b) Enthalpy (c) Gibbs free energy (d) Helmholtz free energy	1	K2	CO4
16.	The difference between specific heats Cp and Cv for an ideal gas is: (a) $c_p - c_v = R$ (b) $c_p - c_v = 2R$ (c) $c_p - c_v = R/2$ (d) $c_p - c_v = 0$	1	K1	CO4
17.	Dalton's Law states that: (a) The total pressure of a gas mixture is the sum of the partial pressures of the individual gases (b) The volume of a gas mixture is equal to the sum of the volumes of individual gases (c) Gases in a mixture do not interact with each other (d) The temperature of a gas mixture is the sum of the temperatures of the individual gases	1	K1	CO5
18.	The mole fraction of a component in a gas mixture is: (a) The ratio of the moles of that component to the total moles of the mixture (b) The ratio of the mass of that component to the total mass of the mixture (c) The ratio of the volume of that component to the total volume of the mixture (d) The ratio of the temperature of that component to the total temperature of the mixture	1	K1	CO5
19.	The dew point temperature is: (a) The temperature at which air becomes saturated with water vapor (b) The temperature at which water vapor starts to condense (c) Always higher than the dry-bulb temperature (d) The temperature at which a mixture reaches maximum humidity	1	K1	CO5
20.	Evaporative cooling is most effective when the air is: (a) Dry (b) Humid (c) Hot and humid (d) Cold and dry	1	K2	CO5

PART - B (10 × 2 = 20 Marks)

Answer ALL Questions

21.	What is extensive property and give an example?	2	K1	CO1
22.	Write the steady flow energy equation for the evaporator.	2	K2	CO1
23.	What is a Perpetual motion machine of the second kind?	2	K1	CO2
24.	What are the important characteristics of entropy?	2	K1	CO2
25.	Define dryness fraction of steam.	2	K1	CO3
26.	Name the different process of Rankine cycle on T-S diagram.	2	K2	CO3
27.	State Boyle's and Charles law.	2	K1	CO4
28.	What do you understand by the law of corresponding states?	2	K2	CO4
29.	Define dew point temperature.	2	K1	CO5
30.	Define (a) Mole fraction, and (b) Mass fraction.	2	K1	CO5

PART - C (6 × 10 = 60 Marks)

Answer ALL Questions

31.	a)	A gas contained in a cylinder is compressed from 1 MPa and 0.05 m^3 to 2 MPa. Compression by $PV^{1.4}$ constant internal energy is U = 7.5 PV, kJ, where P in kPa and V in m^3. Determine heat, work and ΔU. 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?	10	K3	CO1

OR

	b)	A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. (1) Find the velocity at exit from the nozzle. (2) If the inlet area is 0.1 $m^2$and the specific volume at the inlet is 0.187 m^3/kg, find the mass flow rate.	*10*	*K3*	*CO1*
32.	a) i)	A heat pump operates on a Carnot heat pump cycle with a COP of 8.7. It keeps a space at 24^0C by consuming 2.15 kW of power. Determine the temperature of the reservoir from which the heat is absorbed and the heating load provided by the heat pump.	*5*	*K3*	*CO2*
	ii)	An inventor claims to have developed a refrigeration system that removes heat from the closed region at -12^0C and transfers it to the surrounding air at 25^0C while maintaining a COP of 6.5. Is this claim reasonable? Why?	*5*	*K3*	*CO2*
		OR			
	b)	A 30 kg iron block and a 40 kg copper block, both initially at 800C, are dropped into a large lake at 150C. Thermal equilibrium is established after a while as a result of heat transfer between the blocks and the lake water. Determine the total entropy change for this process.	10	*K3*	*CO2*
33.	a)	A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, mass, specific volume, enthalpy, entropy and internal energy.	*10*	*K3*	*CO3*
		OR			
	b)	Consider a steam power plant operating on the ideal reheat Rankine cycle. Steam enters the high-pressure turbine at 18MPa and 923K 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 12.4 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.	*10*	*K3*	*CO3*
34.	a) i)	Explain the physical significance of the compressibility factor Z.	*5*	*K2*	*CO4*
	ii)	Derive the Joule – Thomson co-efficient equation and draw the inversion curve.	*5*	*K2*	*CO4*
		OR			
	b)	Derive Tds equation when			
	i)	T and V independent and	*5*	*K2*	*CO4*
	ii)	T and P independent.	*5*	*K2*	*CO4*
35.	a)	Two air streams are mixed steadily and adiabatically, the first stream enters at 35°C and 30% R.H at a rate of 15m^3/min, while the second stream enters at 12°C and 90% R.H. at a rate of 25m^3/min. Assuming that the mixing process occurs at a pressure of 1 atm, determine the specific humidity, relative humidity, dry bulb temperature and volume flow rate of the mixture.	*10*	*K3*	*CO5*
		OR			
	b)	A gaseous mixture consists of 1 kg of oxygen and 2 kg of nitrogen at a pressure of 150 kPa and a temperature of 20°C. Determine the changes in internal energy, enthalpy of the mixture when the mixture is heated to a temperature of 100°C (a) at constant volume, and (b) at constant pressure.	*10*	*K3*	*CO5*
36.	a) i)	State cyclic relation and reciprocity relation.	*5*	*K2*	*CO4*
	ii)	Explain the following Air- conditioning process - Sensible cooling and sensible heating process.	*5*	*K2*	*CO5*
		OR			

b) i)	State four Gibbs functions and Maxwell's relations.	*5*	*K2*	*CO4*
ii)	Explain the following Air- conditioning process - Cooling and dehumidification process.	*5*	*K2*	*CO5*