Q. Code:855628

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

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2024

Third Semester

AE22301 - BASIC AND APPLIED THERMODYNAMICS

(Automobile Engineering)

(Regulations 2022)

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

TIME: 3 HOUR **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO1	Analyze various energy transferring / transforming equipment using I law of thermodynamics.	**3**
CO2	Analyze various energy transforming equipment and Heat and Reversed heat engines using II law of thermodynamics.	**3**
CO3	Obtain different thermodynamic relations & equations for ideal and real gases from basics and to estimate the properties of gas mixtures.	**3**
CO2	Analyze the performance of steam power plant cycle and with the help of steam table and charts.	**3**
CO4	Discuss the process of steam generation and analyze steam flow through nozzles and steam power cycles.	**3**
CO5	Analyze thermodynamically the refrigeration and refrigeration cycles.	**3**

PART-A (20 x 2 = 40 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	Differentiate between thermal equilibrium and mechanical equilibrium.	**1**	**2**
2.	If a gas of volume 30 m^3 is contained in a rigid container and 60 J of heat is provided to it. Then, calculate the change in internal energy. Assume that the gas exerts 1atm of pressure on the walls.	**1**	**3**
3.	Define the isothermal process? What is the value of change in internal energy during it?	**1**	**2**
4.	Show the heat transfer during a non-flow constant temperature process using area concept on Ts diagram.	**1**	**3**
5.	Differentiate between Source and Sink. Will heat transfer to the thermal reservoirs affect its temperature?	**2**	**3**
6.	Show schematically the impossible Kelvin Planck statement.	**2**	**3**
7.	When is there a violation of Kelvin's statement of the second law?	**2**	**3**
8.	Which of the following is true? a) for an isolated system, dS>=0 b) for a reversible process, dS=0 c) for an irreversible process, dS>0	**2**	**3**

d) all of the mentioned

9.	Particular air contains 23% O_2 and 77 % N_2 by mass. Determine the molecular weight, and gas constant at NTP.	**3**	**3**
10.	Differentiate between isothermal and compressibility.	**3**	**2**
11.	Prove that the internal energy of an ideal gas is function of temperature only.	**3**	**3**
12.	Show that Joule Thomson coefficient is zero on inversion curve.	**3**	**3**
13.	What is the effect of sensible heat and latent heat supply on temperature during steam generation at constant pressure?	**4**	**2**
14.	10 kg/s of water is heated from 20°C to 100°C at constant pressure. Calculate the amount of sensible heat required if the specific heat at constant pressure is 4200 J/kg-K.	**4**	**3**
15.	Which type of nozzle is used for increasing the velocity of steam at M > 1 & p > 50 bar?	**4**	**2**
16.	Define critical pressure ratio related to steam nozzle. What is its value when the index of expansion is 1.3?	**4**	**3**
17.	Why is wet compression not preferred?	**5**	**2**
18.	What is the effect of under-cooling and superheating on refrigeration effect?	**5**	**2**
19.	Which component of vapour compression system produces refrigeration effect?	**5**	**2**
20.	Compare vapour compression and vapour absorption refrigeration systems with respect to weight and mechanical energy consumption.	**5**	**3**

PART-B (5 x 10 = 50 Marks)

		Marks	CO	RBT LEVEL
21. (a)	**0**.6 m^3 of air at 30°C and 1 bar is compressed polytropically to 0.08 m^3. Find the final pressure and temperature and workdone, change in internal energy and enthalpy, when the index of compression has the value of 1.5. Take for air C_p = 1.005 kJ/kg-K and C_v = 0.718 kJ/kg-K.	**(10)**	**1**	**4**
	(OR)			
(b)	A centrifugal pump delivers 2850 kg of water per min from initial pressure of 0.8 bar absolute to a final pressure of 2.8 bar absolute. The suction is 2 m below and the delivery is 5 m above the centre of pump. If the suction and delivery pipes are of 15 cm and 10 cm diameters respectively, make calculation for power required to run the pump.	**(10)**	**1**	**4**
22. (a)	A Carnot engine is operated between two reservoirs at temperatures of	**(10)**	**2**	**3**

400 K and 325 K. If the engine receives 300 kJ of heat from the source in each cycle, calculate the amount of heart rejected to the sink in each cycle. Calculate the efficiency of the engine and the workdone by the engine in each cycle.

(OR)

(b)	Two kg of air at 500 kPa, 80°C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 kPa, 5°C. For this process, determine (a) the maximum work, (b) the change in availability, and (c) the irreversibility.	**(10)**	**2**	**3**
23. (a)	A vessel of 0.45 m^3 capacity contains 0.4 kg of carbon monoxide (Molecular weight = 28) and 1 kg of air at 20°C. Calculate the partial pressure of each component and the total pressure in the vessel. The gravimetric analysis of air is to be taken as 23.3% O_2 and 76.7% N_2.	**(10)**	**3**	**3**

(OR)

(b)	Derive first and second T ds equations.	**(10)**	**3**	**3**
24. (a)	Dry saturated steam at pressure of 10 bar flows through nozzles at the rate of 4.6 kg/s and discharges at a pressure of 1.5 bar. The loss due to friction occurs only in the diverging portion of the nozzle and its magnitude is 12 % of the total isentropic enthalpy drop. Assume the isentropic index of expansion n = 1.135, determine the cross sectional area at the throat and exit of the nozzles.	**(10)**	**4**	**3**

(OR)

(b)	In a steam power plant operating on an reheat Rankine cycle, the steam enters the high pressure turbine at 3 MPa and 400°C. After expansion to 0.6 MPa, the steam is reheated to 400°C and then expanded in the low pressure turbine to the condenser pressure of 10 kPa. Determine the thermal efficiency of the cycle and the quality of the steam at the outlet of the low pressure turbine.	**(10)**	**4**	**3**
25. (a)	A vapour compression refrigerator uses methyl chloride and operates between temperature limits of – 10°C and 45°C. At entry to the compressor, the refrigerant is dry saturated and after compression it	**(10)**	**5**	**3**

acquired a temperature of 60°C. Find the COP of the refrigerator. Take the following properties:

Temperature (°C)	Specific Enthalpy (kJ/kg)		Specific entropy (kJ/kgK)	
	Liquid	Vapour	Liquid	Vapour
45	133.0	483.6	0.485	1.587
-10	45.4	460.7	0.183	1.637

(OR)

(b)	Differentiate between a vapour compression refrigeration system and vapour absorption system. Suggest a suitable refrigeration system for a large scale chilling plant of 250 TR and explain its working principles.	**(10)**	**5**	**3**

PART-C (1 x 10 = 10 Marks)
(Q.No.26 is compulsory)

		Marks	CO	RBT LEVEL
26.	Discuss the possibility of using vapour absorption refrigeration system for automotive air conditioning.	**(10)**	**5**	**3**