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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth Semester B.Tech Degree Supplementary Examination June 2023 (2019 scheme)

Course Code: MET202

Course Name: ENGINEERING THERMODYNAMICS

Max. Marks: 100 Duration: 3 Hours

Use of steam tables, Mollier diagram and compressibility charts are permitted

PART A

(Answer all questions; each question carries 3 marks) Marks

1	Differentiate between macroscopic and microscopic analyses in thermodynamics. How does the concept of continuum relate to the above?	3
2	What is a thermocouple? How does it work? State the thermometric property used in thermocouples.	3
3	How does flow work differ from displacement work?	3
4	A gas enclosed in a cylinder piston assembly expands from 2 m^3 to 4 m^3. The pressure volume correlation is given by $p = V^2 + \frac{6}{V}$, where p is in bar. Determine the work done by the system, considering the process as non-flow and reversible.	3
5	Describe the limitations of first law of thermodynamics, with the help of suitable example.	3
6	An inventor claims that he invented a cyclic heat engine that can produce work continuously by receiving heat from a higher temperature reservoir, and without leaving any heat to the lower temperature reservoir. Is his claim correct or not? Justify your answer.	3
7	What are compressed liquid, superheated vapour, and quality of vapour?	3
8	Write a short note on Mollier diagram.	3
9	State Dalton's law of partial pressure. How is the partial pressure of a component in a gaseous mixture related to the mole fraction of that component?	3
10	Show, with the help of appropriate property relation, that the saturation pressure of a liquid increases with temperature, in a phase change process from liquid to vapour.	3

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

11 a) Differentiate between thermodynamic system and control volume with the help of at least one example for each. What is meant by thermodynamic equilibrium of a system? Give a brief description on the conditions to be satisfied for a system to be in thermodynamic equilibrium. 8

b) With the help of an example, describe the concept of a quasi-static process. Illustrate - isobaric, isothermal, and adiabatic processes on p-v plot within the same diagram. 6

12 a) State Zeroth law of thermodynamics. What is its significance? Describe Celsius scale and its corresponding absolute scale. Which is the fixed point used in the measurement of temperature in Celsius scale? Show the mathematical relation connecting the absolute temperature and the thermometric property, in terms of the fixed point. 8

b) The temperature 't' on a thermometric scale is defined in terms of property K by the relation $t = alnK + b$, where a and b are constants. The values of K are found to be 1.52 and 8.79 at the ice point and steam point, the temperatures of which are assigned the numbers 0^0C and 100^0C respectively. Determine the value of K at 25^0C and 50^0C? 6

Module -2

13 a) State first law of thermodynamics for a cycle, and for a closed system undergoing a change of state. Explain the terms in the above relationships.
What is a PMM1? Is a PMM1 possible? 7

b) A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 MPa to a final state of 0.15 m^3 and 0.105 MPa, the pressure remaining constant during the process. There is a transfer of heat 37.6 kJ from the gas during the process. How much does the internal energy of the gas change? 7

14 a) Derive Steady flow energy equation (for one inlet and one outlet stream each), and from it deduce an expression for the work done by a steam turbine, with proper simplifications. 7

b) Air at 110 K and 101.32 kPa is passing through a converging nozzle and leaves at 300 K. Determine the velocity of air at nozzle outlet. The nozzle is laid horizontal. The inlet velocity of air is 10 m/s. Write the assumptions made. 7

Module -3

15 a) With the help of schematic diagrams describe cyclic heat engine, cyclic heat pump and cyclic refrigerator. How they differ purpose wise? Define the performance parameters of the above three machines. 7

b) Two reversible heat engines operate in series between two end temperatures 600K and 300K via an intermediate thermal reservoir. Both the engines develop the same power. Determine the temperature of the intermediate thermal reservoir. 7

16 a) Give the statement of third law of thermodynamics and explain it. 7
Will a reversible and adiabatic process surely be isentropic? Justify your answer. Comment on the reverse statement; that is, Will an isentropic process surely be reversible and adiabatic? Justify your answer.

b) A heat engine is embedded between two temperature reservoirs 500 K and 300 K. In three different cycles which it rejects 210 kW, 180 kW and 150 kW, while receiving heat at the rate of 300 kW in each case. 7
Justify in which case the engine runs reversibility and irreversibility. Also look for the impossible.

Module -4

17 a) Explain the terms - critical state, critical pressure, critical temperature, and critical volume. Show the critical state point on any suitable phase change diagram. Differentiate between sensible heat and latent heat. 7

b) A steam at 2 MPa has a specific volume of 0.09 m^3/kg. Determine the dryness fraction of the steam. Also calculate the specific enthalpy and specific entropy. Use steam table for the above calculations. 7

18 a) Give descriptions on the following. 7
Virial expansions, Law of corresponding states and generalised compressibility chart.

b) Determine the specific volume of nitrogen at 100 atm and 300 K. For nitrogen 7
P_c=3390 kPa
T_c= 126.2 K

Module -5

19 a) State and prove Dalton's law of partial pressures. Obtain the relationships for the characteristic gas constant and molecular weight of a gas mixture from their component characteristics. 7

b) A vessel divided into two chambers by a partition wall contains oxygen gas in either chamber 7

Chamber -1	Chamber –II
P= 1500 kPa	P= 600kPa
T= 323 K	T= 292K
Mass of oxygen = 0.5 mol	Mass of oxygen =2.5 kg

Determine the final equilibrium pressure?

Take γ=1.4

Assume oxygen behaves ideally throughout the process?

20 a) What is a throttling process? Give a description on Joule Thomson coefficient with its significance. What would be the value of Joule Thompson coefficient for ideal gas and how would it adversely influence the refrigeration effect in a throttling process? 6

b) Derive Maxwell relations, beginning from the appropriate combined first and second laws. 8

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