Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third Semester B.Tech Degree (S,FE) Examination January 2022 (2015 Scheme)

Course Code: ME205

Course Name: THERMODYNAMICS

Use of steam tables permitted

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10marks. Marks

1 a) Define i) system ii) surroundings iii) boundary, and iv) universe (4)

b) Distinguish between microscopic and macroscopic approach. (3)

c) Describe briefly the concept of continuum. (3)

2 a) With a neat sketch, explain the working of a constant volume gas thermometer. (6)

b) Distinguish between heat transfer and work transfer (4)

3 a) Derive the steady flow energy equation. (6)

b) A stationary mass of gas at an initial state of 0.4 m^3, 100 kPa is isobarically compressed to 0.2 m^3. During this process, there is a transfer of 43.5 kJ of heat from the gas. Calculate the change in internal energy of the gas. (4)

4 a) Show that energy is a system property. (4)

b) In an air compressor having a flow rate of 0.5 kg/s, the inlet conditions are 7 m/s velocity, 100 kPa pressure, and 0.95 m^3/kg volume. The corresponding exit conditions are 5 m/s, 700 kPa, and 0.19 m^3/kg. During this process, the internal energy of air increases by 90 kJ/kg. Heat is transferred at a rate of 60 kW to the surroundings. Assuming steady flow, find the rate of shaft work input required for compression. (6)

PART B

Answer any three full questions, each carries 10marks.

5 a) State Kelvin-Planck and Clausius statements of second law of thermodynamics. (4)

b) Prove the equivalence of Kelvin-Planck and Clausius statements. (6)

6 a) Establish the Clausius inequality. (4)

b) State and prove Carnot's theorem. (6)

7 a) Define available energy and unavailable energy. (2)

b) Second law of thermodynamics is called law of degradation of energy. Comment. (3)

c) Show that available energy decreases when heat is transferred through a finite temperature difference. (5)

8 a) Draw the p-v diagram of a pure substance whose volume decreases during melting. Show all the important lines in the diagram. (4)

b) Steam expands isentropically in a turbine from 1.5 MPa, 300^{o}C to a final state, where the temperature of the steam is 40^{o}C. Determine the final condition of the steam. Also find the ideal work output per kg of steam. (6)

PART C

Answer any four full questions, each carries 10marks.

9 a) Write down the van der Waals equation of state. How does it differ from the ideal gas equation of state? (4)

b) Derive the expression of law of corresponding states from van der Waals equation. (6)

10 a) What are reduced properties? What is the significance of compressibility factor chart? (4)

b) An ideal gas of mass of 0.5 kg has a pressure of 300 kPa, a temperature of 80°C, and a volume of 0.14 m^3. The gas undergoes an irreversible adiabatic process and to a final pressure and volume is 300 kPa and 0.20 m^3 respectively. During this process, the work done on the gas is 50 kJ. Evaluate the two specific heat values and the increase in entropy of the gas. (6)

11 a) Explain Amagat's law of additive volumes. (4)

b) Nitrogen gas (M = 28) is stored in two vessels A and B both are separated by a valve. Vessel A contains 15 kg of nitrogen at a pressure of 1.5 MPa and temperature 50^{o}C. Vessel B contains 2.5 kg of nitrogen at a pressure of 600 kPa and temperature 20^{o}C. Now the valve is opened to allow the contents to mix, the resulting equilibrium temperature is 27^{o}C. Find the equilibrium pressure of the mixture. (6)

12 From the basic thermodynamics property relations for a pure substance undergoing an infinitesimal reversible process, derive the Maxwell's equations. Hence derive the two TdS equations. (10)

13	a)	What is Joule-Thomson coefficient? What is its significance?	(4)
	b)	Derive the Clausius Clapeyron equation.	(6)
14	a)	Define adiabatic flame temperature. How is it important? How can it be estimated?	(5)
	b)	Define enthalpy of combustion and heating value. What is the difference between higher heating value and lower heating value of a fuel?	(5)

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