Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth Semester B.Tech Degree Examination July 2021 (2019 Scheme)

Course Code: MET202

Course Name: ENGINEERING THERMODYNAMICS

(Permitted to use Steam tables and Mollier charts)

Max. Marks: 100 Duration: 3 Hours

PART A

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

1		What do you mean by macroscopic and microscopic approaches in thermodynamics?	3
2		What do you mean by ideal gas temperature scale	3
3		Explain positive and negative heat and work interactions.	3
4		Which property of system increases when heat is transferred: (a) at constant volume, (b) at constant pressure? Give the expressions for these properties in terms of specific heats.	3
5		What are the causes of irreversibility of a process?	3
6		Give the Kelvin-Planck and Clausius' statements of second law of thermodynamics.	3
7		What is critical state? Explain the terms critical pressure, critical temperature and critical volume of water.	3
8		What is the fundamental property of gas with respect to the product pv? Differentiate Universal and characteristic gas constants.	3
9		What are reduced properties?	3
10		Why there is no temperature change when ideal gas is throttled?	3

PART B

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

Module -1

11	a)	Explain quasi static process with suitable sketches.	7
	b)	Describe about (i) system and control volume (ii) properties, state, path and process with respect to thermodynamics.	7
12	a)	Explain different types of temperature scales.	7
	b)	A new absolute temperature scale is proposed. On this scale the ice point of	7

water is 150°S and the steam point is 300°S. Determine the temperature in °C that corresponds to 100°S and 400°S respectively. What is the ratio of the size of the °S to the Kelvin? At what temperature both the Celsius and the new temperature scale reading would be the same?

Module -2

13 a) Explain first law of thermodynamics for a closed system undergoing change of state. Show that energy is a property of the system 7

b) A fluid is confined in a cylinder by spring-loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume (p = a + bV). The internal energy of the fluid is given by the equation (U = 34 + 3.15 pV), where U in kj, p in kPa, and V in cubic metre. If the fluid changes from an initial state of 170 kPa, 0.03 m^3 to a final state of 400 kPa, 0.06 m^3, with no work other than that done on the piston. Find the direction and magnitude of the work and heat transfer. 7

14 a) Discuss the application of steady flow process in following engineering systems: (i) Nozzle and Diffuser (ii) Throttling device (iii) Turbine and Compressor 7

b) Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800°C. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650°C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500°C. If the air flow rate is 2kg/s, calculate: 7

(a) The rate of heat transfer to the air in the heat exchanger,

(b) The power output from the turbine assuming no heat loss, and

(c) The velocity at exit from the nozzle, assuming no heat loss.

Take the enthalpy of air as $h=c_pt$; where c_p is the specific heat equal to 1.005 kJ/kg K and t is the temperature.

Module -3

15 a) Derive Clausius inequality and explain the criteria with respect to a cyclic process. 7

b) A heat pump working on the Carnot cycle takes in heat from a reservoir at 10°C and delivers heat to a reservoir at 80°C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 1000°C and rejects heat to a 7

reservoir at 80°C. The reversible heat engine also drives a machine that absorbs 50 kW. If the heat pump extracts 10 kJ/s from the 10°C reservoir, determine

(a) The rate of heat supply from the 1000°C source, and

(b) The rate of heat rejection to the 80°C sink.

16 a) Explain the mixing of two fluids with respect to entropy principle. 7

b) Calculate decrease in available energy when 25 kg of water at 95°C mix with 35kg of water at 35°C, the pressure being taken as constant and the temperature of the surroundings being 15°C (c_p of water = 4.2 kJ/kg K) 7

Module -4

17 a) Explain with P-V diagram, the different stages for a substance whose volume decreases on melting. 7

b) Steam at 0.8 MPa, 250°C and flowing at the rate of 1kg/s passes into a pipe carrying wet steam at 0.8 MPa, 0.95 dry. After adiabatic mixing the flow rate is 2.3 kg/s. Determine the condition of steam after mixing and degree of superheat. 7

18 a) Explain Compressibility factor with respect to Virial expansions. 7

b) What are reasons for the deviation of the real gas behaviour from the ideal gas behaviour? With reference to van der Waals correction, explain the deviation of equation of state of a real substance from ideal gas. 7

Module -5

19 a) State and explain Dalton's law of partial pressures and Amagat's laws of additive volumes. 7

b) A mixture of ideal gases consists of 3kg of nitrogen and 5kg of carbon dioxide at a pressure of 300 kPa and a temperature of 20°C. Find, 7

(a) The mole fraction of each component.

(b) The equivalent molecular weight of the mixture.

(c) The equivalent gas constant of the mixture.

(d) The partial pressure and the partial volumes.

20 a) Explain Joule-Kelvin effect with respect to significance of inversion curve. Show that for an ideal gas, Joule-Kelvin coefficient is zero 7

b) Derive Maxwell's equations 7

*****