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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 22AS3ESTDN **Max Marks: 100**
Course: Thermodynamics **Date: 08.05.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Scientific calculator and steam data handbook are permitted to use.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1 a) Distinguish between: **6**
i) Classical and Statistical thermodynamics.
ii) Open system and Closed system
iii) Intensive and Extensive properties

b) What is absolute temperature? Explain with the help of fundamental law. **4**

c) The readings T_a and T_b of a Celsius thermometers A and B agrees at ice point and steam point respectively. They are related by the equation $T_a = L + m * T_b + n * {T_b}^2$, between these 2 points where L, m and n are constants. when both of these thermometers are immersed in oil bath, T_a registers 55 ^{o} C and T_b registers 50^o C, Determine the values of L,m and n and also find the reading on A when B registers 25^{o}C. **10**

UNIT - II

2 a) With a neat sketch explain the famous Joule's law. **7**

b) In an aircraft engine, compressed air at 3 bar and 450K enters a combustion chamber in which heat is added at constant pressure to the air by the combustion of fuel. Air is thus heated to a temperature of 1250 K. It then enters a turbine with a negligible velocity. It expands in the turbine until its temperature falls to 1000 K. The velocity of air leaving the turbine is 50 m/s. Air then enters a convergent divergent nozzle where in it expands until its temperature drops to 800 K. Flow through both turbine and nozzle may be considered as reversible adiabatic. Determine i) heat added in the combustion chamber per kg of air ii) work done in the turbine per kg of air iii) velocity of air leaving the nozzle iv) pressure of air leaving the turbine and at exit from the nozzle. Write the necessary diagram. **10**

c) What is PMM1? **3**

UNIT - III

3	a)	State and explain the Kelvin Plank and Clausius statement of II law with the help of diagram.	**7**
	b)	A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and -20°C. The heat transfer to the heat engine is 2500 kJ and the net work output of the combined engine refrigerator plant is 360 kJ. a.) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. b.) Reconsider a) given that the efficiency of the heat engine and the COP of the refrigerator are each 40 % of their maximum possible values.	**10**
	c)	Write a note on thermal energy reservoir.	**3**

OR

4	a)	State and prove "Clausius Inequality"	**8**
	b)	What are the factors affecting reversibility?	**4**
	c)	One kg of ice at -5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere. i) Determine the entropy increase of the universe.	**8**

UNIT - IV

5	a)	Define the following terms with reference to the pure substances and also represent on the TS diagram. i) Latent heat of vaporization ii) Subcooled liquid iii) Degree of superheat iv) Dryness fraction	**10**
	b)	A mixture of ideal gases consist of 3kg of nitrogen and 5kg of CO_2 at a pressure of 300kPa and a temperature of 20°C. Find i) The mole fraction of each constituent ii) The equivalent molecular weight of the mixture iii) The equivalent gas constant of the mixture iv) The partial pressure and the partial volumes v) The volume and density of the mixture vi) The C_p and C_v of the mixture	**10**

OR

6	a)	Explain the following: i) Compressibility factor ii) Reduced properties iii) Law of corresponding states iv) Vander walls equation of state v) Universal gas constant	**10**
	b)	Steam initially at 1.5 Mpa, 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the ideal work output of the turbine per kg of steam.	**6**

c) Show that for an ideal gas, $C_p - C_v = R$ **4**

UNIT - V

7 a) With the help of P-V and T-S diagram. Derive an expression for the air standard efficiency of an Otto cycle. **8**

b) Compare Otto cycle, Diesel cycle and Dual cycle with the help of PV or TS diagram. **4**

c) Explain the Rankine cycle with a neat sketch and mention the various methods to improve the efficiency of Rankine cycle with the help of a TS diagram. **8**

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