

M.E. MECHANICAL ENGINEERING - FIRST YEAR - SECOND SEMESTER EXAMINATION, 2024**COMBUSTION ENGINEERING****Time: Three hours****Full Marks 100**

	All parts of the same question must be answered together. Assume any unfurnished data suitably	
	Use of Thermodynamic Tables and Charts permitted	
	Answer any five questions	
Q:1.	(a) What is enthalpy of formation? (b) Stoichiometric H ₂ -O ₂ mixture at 298 K, 1 bar is burned at constant pressure. Water is added as spray and evaporates completely. If the mass of water added is 0.1% of the mass of hydrogen, find the final temperature.	5 15
Q:2	(a) What is equilibrium flame temperature? (b) Consider the combustion of methane in air with an equivalence ratio of 0.85. If the composition products exit at 1800 K, what is the composition of the products if the only dissociation reaction involved is the carbon dioxide dissociation reaction?	5 15
Q:3	(a) In their survey of experimental determinations of rate coefficients for the N-H-O system, Hanson and Salimian recommend the following rate coefficient for the reaction $\text{NO} + \text{O} \rightarrow \text{N} + \text{O}_2$: $k_f = 3.80 \cdot 10^9 T^{1.0} \exp(-20,820/T) [=] \text{cm}^3/\text{gmol}\cdot\text{s}.$ Determine the rate coefficient k_r for the reverse reaction, i.e., $\text{N} + \text{O}_2 \rightarrow \text{NO} + \text{O}$, at 2000 K. (b) Derive the half-life of a second-order reaction with identical reactants $\text{A} + \text{A} \rightarrow \text{P}$	12 8
Q: 4	(a) Derive the species conservation equation in rectangular coordinate system. (b) How the quenching diameter is estimated?	12 8
Q: 5	(a) Draw the typical structure of a premixed flame. (b) How an estimate of flame speed is obtained by Mallard and Le Chatelier?	8 12
Q: 6	(a) Derive the relationship between equilibrium constant based on partial pressures and concentrations. (b) Find the difference between the adiabatic flame temperature for methane - air reaction occurring in constant pressure and constant volume chambers.	14 6
Q:7	(a) Define flammability limits. (b) What experimental methods are used to measure flame speed, and how does each method function? (c) Develop a transient mixture fraction conservation equation in one dimension.	4 6 10