U.S.N.										

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

Autonomous Institute Affiliated to VTU

October 2024 Supplementary Examinations

Programme: B.E. **Semester: VI**

Branch: Aerospace Engineering **Duration: 3 hrs.**

Course Code: 22AS6PCCOM **Max Marks: 100**

Course: Combustion

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Combustion table is 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	CO	PO	Marks
1	a)	Define the following i) Mass fraction ii) Mole fraction iii) Equivalence ratio iv) Standardized enthalpy	CO1	PO1	**8**
	b)	Consider a mixture of N_2 and Ar in which there are three times as many moles of N_2 as there are moles of Ar. Determine the mole fractions of N_2 and Ar, the molecular weight of the mixture, the mass fractions of N_2 and Ar and the molar concentration of N_2 in kmol/m^3 for a temperature of 500 K and a pressure of 250 kPa. (MW of N_2 =28 and Ar = 40)	CO2	PO1 PO2	**8**
	c)	Determine the stoichiometric air-fuel ratio (mass) for propane.	CO1	PO1	**4**
		OR			
2	a)	Why do you need to study combustion?	CO1	PO1	**4**
	b)	Find the equilibrium constant at 2000 K for the reaction shown below, $CO_2 \rightarrow CO + 1/2O_2$	CO2	PO2	**8**
	c)	Estimate the constant-volume adiabatic flame temperature for a stoichiometric Methane-air mixture. Initial conditions are Ti = 298 K, P = 1 atm. Enthalpy of formation of methane = -74831 kJ/kmol. Take Cp (kJ/kmol-K) @1200 K for CO_2, H_2O N_2 as 56.21, 43.87 and 33.71 respectively.	CO2	PO2	**8**
		UNIT - II			
3	a)	For the given reaction below find the net rate of production of N_2, O_2, NO, O, N, having k_1, k_2, k_{3f} and k_{3b} as the rate constant for the reactions respectively. $N_2 + O \rightarrow NO + N$ $N + O_2 \rightarrow NO + O$ $O_2 \leftrightarrow 2O$	CO3	PO2	**7**

		b)	Explain the partial equilibrium approximation employed in chemical kinetics.	*CO3*	*PO1*	**7**
		c)	Bring out the commonalities among three transport laws, explaining each one with fundamental equation and write the generalized equation.	*CO1*	*PO1*	**6**
			UNIT - III			
	4	a)	Derive an expression for Rankine-Hugoniont relations. Highlight the Hugoniont curves with various regimes.	*CO3*	*PO3*	**8**
		b)	A kitchen room of size 4m x 3m x 3m at 0.1 Mpa and 298 K is filled with propane due to leakage from propane gas cylinder of volume 0.1 m^3 initially at 0.5 Mpa. Assuming that the leakage stops when the pressure in the cylinder reaches 0.1 Mpa, Determine whether the mixture in the kitchen is flammable or not?	*CO3*	*PO3*	**7**
		c)	Explain the steady laminar premixed flame structure highlighting the different zones.	*CO3*	*PO1*	**5**
			OR			
	5	a)	Determine the laminar burning velocity S_L of stoichiometric methane air mixture a conical flame of flame height of 5.1 cm is established using a Bunsen burner with port diameter of 10 mm. If it consumes 19 LPM of fuel-air mixture, determine its burning velocity by area method.	*CO2*	*PO2*	**7**
		b)	What do you mean by quenching diameter? Derive an expression for quenching diameter. State the significance of quenching dia in practical combustors.	*CO3*	*PO3*	**8**
		c)	In a stoichiometric propane air flame N_2 is replaced by He whose original burning velocity S_L is 40 cm/s. Estimate the laminar burning velocity of this new stoichiometric mixture.	*CO3*	*PO1*	**5**
			UNIT - IV			
	6	a)	A laminar butane gas jet issued from a tube into the air has a flame height of 10 cm. Determine the volumetric fuel flow rate and heat release rate. If the fuel tube diameter is increased by 25% and velocity is decreased by 25%, What will be the flame height? Take heat of combustion of butane gas = 45000 kJ/kg, Tad = 2300 K	*CO3*	*PO3*	**8**
		b)	Compare Premixed flame and Diffusion flame. Use necessary sketches.	*CO3*	*PO1*	**5**
		c)	Using phenomenological analysis, derive the laminar jet diffusion flame height. Use necessary sketches.	*CO3*	*PO1*	**7**
			UNIT - V			
	7	a)	Explain the various NOx formation mechanisms in combustion systems.	*CO3*	*PO1*	**8**
		b)	A gas turbine engine uses propane gas. The measured compositions of exhaust gas at dry conditions are given below: O_2 = 4.5 %, CO = 0.15 %, CO_2 = 14.5 %, NOx = 75 ppm. Determine the emission index of NOx.	*CO1*	*PO7*	**6**
		c)	How do emissions from the combustion systems affect human health?	*CO1*	*PO1*	**6**

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