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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main 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)	Compute adiabatic flame temperature for Hydrogen combustion with i) air and ii) oxygen. Compare the results.	*CO2*	*PO2*	**10**
	b)	Why do we need to study combustion?	*CO1*	*PO1*	**4**
	c)	Define mole fraction and mass fraction. Write the relationship between them.	*CO1*	*PO1*	**6**
		OR			
2	a)	In a propane fuelled truck, 3 % (by volume) oxygen is measured in the exhaust stream of the running engine. Assuming complete combustion without dissociation. Determine the air-fuel ratio (mass) supplied to the engine.	*CO2*	*PO2*	**10**
	b)	The gasoline (C_8H_{18}) is burnt with dry air. The volumetric analysis of products on dry basis is CO_2 = 10.02 %, O_2 = 5.62 %, CO = 0.88% and N_2=83.48%. Determine i) A/F ratio ii) equivalence ratio and % stoichiometric air used.	*CO2*	*PO2*	**10**
		UNIT - II			
3	a)	Derive an expression for species governing equation.	*CO3*	*PO3*	**10**
	b)	For the given reaction below find the net rate of production of H_2, X_2, H, HX and X. $X_2 + M \xrightarrow{k_{1,f}} X + X + M$ Chain initiation $X + H_2 \xrightarrow{k_{2,f}} HX + H$ Chain carrying $H + X_2 \xrightarrow{k_{3,f}} HX + X$ Chain carrying $X + X + M \xrightarrow{k_{1,b}} X_2 + M$ Chain termination $H + HX \xrightarrow{k_{2,b}} X + H_2$ Chain carrying.	*CO3*	*PO2*	**10**

			OR			
	4	a)	Explain Partial equilibrium approximation in chemical kinetics with suitable example.	*CO3*	*PO2*	**10**
		b)	Derive an expression for reaction rate of NO atom using the famous Zeldovich mechanism during the formation of nitic oxide.	*CO3*	*PO2*	**10**
			UNIT - III			
	5	a)	A premixed methane-air flame is stabilized on a burner of diameter 8 mm. The methane flow rate is 0.72 lpm and the equivalence ratio of the mixture is 0.9. If the flame height is measured to be 3 cm, find the flame speed of the mixture.	*CO2*	*PO2*	**5**
		b)	What is the difference between the deflagration and detonation? In week deflagration problems pressure variations can be neglected, while in strong detonation or weak detonations pressure variations need to be taken into account. Can you explain why this is so based on the Rankine-Hugoniont curves? Use necessary sketches.	*CO3*	*PO3*	**10**
		c)	What are the various flame measuring techniques?	*CO3*	*PO1*	**5**
			OR			
	6	a)	Calculate the q for a gaseous stoichiometric mixture of CO and O_2. Assume the only products is CO_2. Calculate the detonation pressure if the initial state is at P_1 = 1 bar, ρ_1 = 1 kg/m^3, and the final state is ρ_2 = 3 kg/m^3 .Assume γ = 1.4. Also calculate the C.J detonation speed.	*CO2*	*PO2*	**8**
		b)	The burning velocity of a combustible mixture was determined by employing the nozzle Burner-total area method. The data recorded were as volumetric flow rate of the combustible Mixture = 220 cm^3, height of the mean cone of the flame = 3.83 cm, diameter of the nozzle-burner port = 8.3 mm. Calculate the value of the burning velocity.	*CO2*	*PO2*	**7**
		c)	Explain the structure of laminar premixed flame highlighting the different zones.	*CO3*	*PO1*	**5**
			UNIT - IV			
	7	a)	Compare Premixed flame and diffusion flame. Use necessary sketches.	*CO1*	*PO1*	**6**
		b)	Derive an expression for determining the height of the flame for a laminar jet diffusion flame using phenomenological analysis. Use necessary sketches.	*CO3*	*PO3*	**8**
		c)	Calculate the height of the flame using roper's correlation for butane gas. Take C.V of gas as 45MJ/kg, Tad = 2300 K, if the volumetric flow rate is 3.7 x 10^{-5} m^3/s. Use Roper's correlation.	*CO2*	*PO2*	**6**
			OR			

	8	a)	Explain the physical description of jet flame with a neat sketch.	*CO3*	*PO3*	**6**
		b)	Write a description on Candle flame, highlighting different zones and its temperature variation inside the flame.	*CO3*	*PO3*	**6**
		c)	Derive an expression for quenching diameter and highlight its significance.	*CO3*	*PO3*	**8**
			UNIT - V			
	9	a)	Explain the various NOx reduction techniques employed in combustion technology.	*CO1*	*PO7*	**12**
		b)	Explain the mechanism of soot formation. Use necessary sketches.	*CO1*	*PO1*	**8**
			OR			
	10	a)	How does emissions from the combustion system affect human health?	*CO1*	*PO1*	**5**
		b)	Calculate the CO_2 emissions for the fuels below and which one among them is better in terms of CO_2 emissions. Take wood as $C H_{1.4} O_{0.06}$, LPG (80% butane and 20 % Propane) and Petrol, assuming stoichiometric combustion with air.	*CO1*	*PO7*	**7**
		c)	What are the various NOx formation mechanism in combustion?	*CO1*	*PO7*	**8**

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