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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

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

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

Course Code: 23AS6PCCOM/20AE6DCCOM/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. Use of Combustion data handbook 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 stoichiometry. Discuss in detail about combustion stoichiometry with an example. How it is related with the equivalence ratio?	*CO1*	*PO1*	**08**
	b)	A small, low-emission, stationary gas turbine engine operates at full load (3950 kW) at an equivalence ratio of 0.286 with an air flow rate of 15.9 kg/s. The equivalent composition of the fuel (natural gas) is $C_{1.16}\ H_{4.32}$. Determine the fuel mass flow rate and the operating air–fuel ratio for the engine.	*CO2*	*PO2*	**08**
	c)	Why is the equivalence ratio frequently more meaningful than the air–fuel (or fuel–air) ratio when comparing different fuels?	*CO1*	*PO1*	**04**
		OR			
2	a)	Derive an expression for equilibrium constant K_p using Gibb's function.	*CO2*	*PO1*	**08**
	b)	Estimate the constant-pressure adiabatic flame temperature for the combustion of a stoichiometric CH_4–air mixture. The pressure is 1 atm and the initial reactant temperature is 298 K. Use the following assumptions: i) Complete combustion (no dissociation), i.e., the product mixture consists of only CO_2, H_2O, and N_2. ii) The product mixture enthalpy is estimated using constant specific heats evaluated at 1200 K (=0.5(T_i + T_{ad}) where T_{iad} is guessed to be about 2100 K).	*CO2*	*PO2*	**08**

Species	Enthalpy of Formation @ 298 K $\bar{h}^o_{f,i}$ (kJ/kmol)	Specific Heat @ 1200 K $\bar{c}_{p,i}$ (kJ/kmol-K)
CH_4	−74,831	—
CO_2	−393,546	56.21
H_2O	−241,845	43.87
N_2	0	33.71
O_2	0	—

		c)	Analyze the various parameters influencing the equivalence ratio.	*CO1*	*PO1*	**04**
			UNIT - II			
	3	a)	Write a short note on various steps involved in elementary reactions.	*CO3*	*PO1*	**08**
		b)	What is partial-equilibrium approximation in chemical kinetics? Explain it with a suitable example.	*CO3*	*PO1*	**12**
			OR			
	4	a)	Derive an expression for species conservation equation.	*CO3*	*PO1*	**12**
		b)	Consider a non-premixed jet flame in which the fuel is C_3H_8 and the oxidizer is an equimolar mixture of O_2 and CO_2. The species existing within the flame are C, CO, CO_2, O_2, H_2, H_2O, and OH. Determine the numerical value of the stoichiometric mixture fraction f_{stoic} for this system.	*CO2*	*PO1*	**08**
			UNIT - III			
	5	a)	List the various methods used in the measurement of flame speed. Explain them with neat sketches.	*CO3*	*PO1*	**10**
		b)	Derive an expression for the Quenching distance. Highlight its physical significance.	*CO3*	*PO3*	**10**
			OR			
	6	a)	Illustrate the structure of a laminar premixed flame and explain in detail about the various zones of the flame.	*CO3*	*PO1*	**10**
		b)	A gaseous combustible mixture is contained in a long cylindrical glass tube open at one end and closed at the other end. The internal diameter of the tube is 5.5 cm. The speed of the uniform movement of the flame front was determined to be 84 cm/s by igniting the combustible mixture at the open end. Assume flame to be hemispherical. Calculate the burning velocity of the mixture.	*CO2*	*PO2*	**10**
			UNIT - IV			
	7	a)	Draw the laminar diffusion flame structure of jet flame and give the physical description. List pot the various assumptions made.	*CO3*	*PO1*	**10**
		b)	Investigate about the soot formation and destruction zones in laminar jet diffusion flame.	*CO3*	*PO1*	**10**
			OR			
	8	a)	Infer about lift-off velocity, lift-off height and blow-out velocity.	*CO3*	*PO1*	**10**
		b)	Derive the expression for droplet burning time using D^2 law.	*CO3*	*PO1*	**10**

			UNIT - V			
9	a)	Discuss about the various factors affecting the combustion efficiency of a combustion device.	*CO1*	*PO1*	**04**
	b)	Assess the health hazards associated with combustion emissions.	*CO1*	*PO7*	**06**
	c)	Analyze about the NO_x formation mechanism and the methods to control NO_x formation.	*CO1*	*PO7*	**10**
			OR			
10	a)	Infer about the emission reduction technique commonly used in gas turbine combustors.	*CO1*	*PO1*	**04**
	b)	Outline about some of the environmental consequences of combustion products.	*CO1*	*PO7*	**08**
	c)	Analyze about the various parameters influence pollutant formation during combustion.	*CO1*	*PO7*	**08**

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