U.S.N.										

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

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Programme: B.E. **Semester: VI**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 20AE6DCCOM **Max Marks: 100**
Course: Combustion

Instructions:

1. Draw figures wherever necessary.
2. Assume suitable data wherever necessary.
3. Combustion tables 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	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	8
	b)	Differentiate high heating value (HHV) and low heating value (LHV).	CO1	PO1	2
	c)	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. Assume Complete combustion, and the product mixture enthalpy is estimated using constant specific heats evaluated at 1200 K. Use the property values shown in the table (see below)	CO3	PO2	10
		OR			
2	a)	Derive an expression for equilibrium constant for a reversible chemical reaction, using the minimization of Gibb's free energy.	CO1	PO2	10
	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.	CO3	PO2	10

Table for 1 c):

Species	Enthalpy of formation @ 298 K (kJ/mol)	Specific heat @ 1200 K a(kJ/kmole-K)
CH_4	-74831	-
CO_2	-393546	56.21
H_2O	-241845	43.87
N_2	0	33.71
O_2	0	-

			UNIT - II			
	3	a)	Write a short note on law of mass action.	***CO1***	***PO1***	**4**
		b)	In a first order reaction, $O_2 \rightarrow 2O$, it was observed that 40% of O_2 is dissociated in 100 s. Determine its specific reaction rate coefficient. Also calculate the half-life of this reaction.	***CO1***	***PO2***	**6**
		c)	Derive an expression for species conservation equation.	***CO1***	***PO2***	**10**
			UNIT - III			
	4	a)	Differentiate propagation method and stationary method of flame speed measurement.	***CO2***	***PO1***	**4**
		b)	Explain the combustion bomb method of flame speed measurement with a neat sketch.	***CO2***	***PO2***	**6**
		c)	Infer about the following i) Effect of equivalence ratio on flame speed. ii) Flame quenching	***CO2***	***PO2***	**10**
			OR			
	5	a)	Determine the detonation pressure for a gaseous mixture of H_2 and O_2 assuming the product to be only H_2O when this mixture at initial pressure of 0.2 MPa and 300 K increases by three times due to the formation of detonation wave.	***CO2***	***PO2***	**10**
		b)	Explain the effect of initial temperature and pressure on flame speed.	***CO2***	***PO1***	**4**
		c)	Write a short note on flammability limits. How the flammability limit of the fuel is found out.	***CO2***	***PO1***	**6**
			UNIT - IV			
	6	a)	Examine the essential features (flame surface, reaction zone and flame length) of non-premixed laminar free jet flames with necessary figures. Plot the variation of temperature profile, velocity, product and reactant concentration.	***CO2***	***PO1***	**10**
		b)	Define Froude's number. What is physical significance of this number.	***CO2***	***PO1***	**4**
		c)	The methane gas is issued from a tube of 0.5 mm diameter at 298 K and 0.1 MPa. The flow rate of methane gas is 15 LPM. Estimate the flame height by phenomenological analysis assuming the Lewis number (Le) equal to one. Take properties for methane, Kg, thermal conductivity as 0.031 W/(m.K) Cp, specific heat as 2.22 kJ/kg.K	***CO3***	***PO1*** ***PO2***	**6**
			UNIT - V			
	7	a)	Discuss about the various factors affecting the combustion efficiency of a combustion device.	***CO4***	***PO1*** ***PO2***	**6**
		b)	Enumerate the various strategies available to reduce NOx emissions.	***CO4***	***PO1*** ***PO3***	**10**
		c)	Discuss in details about the various health effects arising due to the emissions from combustion systems.	***CO4***	***PO1*** ***PO3***	**4**

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