Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER III–EXAMINATION – WINTER 2015

Subject code: 2732104 **Date: 04/12/2015**

Subject Name: Combustion Engineering

Time: 2:30 PM to 5:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What is adiabatic flame temperature? Describe steady state analysis for open and closed system. **07**

(b) Determine the stoichiometric equation for combustion of (a) Oxygen, (b) Air, (c) Excess fuel. **07**

Q.2 **(a)** Determine the chemical kinematic reaction for (a) H_2-O_2 system (b) Carbon monoxide oxidation. **07**

(b) What is elementary reaction? Explain any two elementary reactions. **07**

OR

(b) Consider a closed rigid vessel initially consists of H_2. The reactor is rapidly heated to a high temperature T, and after heating and before decomposition the pressure becomes P_0.The hydrogen then undergoes a unimolecular reaction **07**

$$H_2 \longrightarrow 2H$$

During decomposition T, is maintained constant. Show that pressure history is given as $P= [H_2]_0\{2-\exp(-k_{uni}(T)\, t)\}\bar{R}T$.

Q.3 **(a)** What is plug flow reactor? Derive expression for it. **07**

(b) Explain constant volume and constant pressure reactor for a fixed mass. **07**

OR

Q.3 **(a)** Consider the reaction of CO with O_2, where air serves as source of O_2: **07**

(a) Show that $\Sigma \dot{w}_k''' = 0$.

(b) Write the mass and species conservation equations for a 2-D flow system. Treat N_2 as inert gas.

(c) If the density is maintained constant, simplify the mass conservation relation.

(b) What is flame stabilization? Explain the stability of flame in premixed gas burner. **07**

Q.4 **(a)** Show that I_f of a cylindrical jet is an invariant. What is the physical meaning of I_f.? **07**

(b) Explain laminar jet with its physical description and chemical reaction. **07**

OR

Q.4 **(a)** Describe the droplet evaporation for diffusion flame. Also find out its governing and conservation equations. **07**

(b) Define the turbulent flow. Determine the governing equations for axisymmetric turbulent flow. **07**

Q.5 **(a)** Under diffusion-controlled combustion, a spherical carbon particle producing CO will burn faster compared with a similar carbon sphere burning to CO_2.True or false? Explain. **07**

(b) Explain the modeling approach for premixed and partially premixed turbulent flames. **07**

OR

Q.5 **(a)** Discuss the characteristic scale of wrinkles in turbulent premixed flame. **07**

(b) Derive the transport equation for $\widetilde{\xi''^2}$ from equation **07**

$$\frac{\partial}{\partial t}(\rho\xi)+\frac{\partial}{\partial x_k}(\rho u_k\xi)=\frac{\partial}{\partial x_k}(\rho D\frac{\partial \xi}{\partial x_k})$$

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