End Semester Examination, May, 2018

Roll No: ----------

Program Name: M.TECH CFD **Semester –II**
Course Name : Reaction Fronts and Combustion **Max. Marks : 100**
Course Code : MCFD 732 **Duration : 3 Hrs**
No. of page/s:03
Heat of Formation Tables are allowed

Instructions: Make use of *sketches/plots* to elaborate your answer. Brief and to the point answers are expected. **The Question paper has three sections: Section A, B and C, Section B and C have internal choices.**

Section A (Attempt ALL questions) **5x4=20 Marks**			
		Marks	Course Outcomes
Q1.	Define Hess's Law. Describe the use of Hess's Law for analysis of chemical reactions. Explain it with an example.	**4**	**CO 2**
Q2.	Why is smaller carbon particle combustion considered to be controlled by kinetics	**4**	**CO 5**
Q3.	Explain about Electronegativity, and its significance in selection of fuels and oxidizers with the examples.	**4**	**CO 1**
Q4.	What do you mean by reversible reaction? Demonstrate the methods of evaluating reversible reaction rate with the help of an example	**4**	**CO 3**
Q5.	What do you mean by auto-ignition temperature of a fuel? How does it effects the design of combustion systems	**4**	**CO 1**
Section B (Attempt ALL questions) **(5 X 8 =40 Marks)**			
6.	Hydrogen (H_2) is burned completely with the stoichiometric amount of air during a steady-flow combustion process. If both the reactants and the products are maintained at 25°C and 1 atm and the water in the products exists in the liquid form, determine the heat transfer from the combustion chamber during this process. What	**8**	**CO 4**

	would your answer be if combustion were achieved with 50 percent excess air		
7.	Methane, CH4, is burned with dry air. The molar analysis of the products on a dry basis is CO2, 9.7%; CO, 0.5%; O2, 2.95%; and N2, 86.85%. Determine (a) the air-fuel ratio on both a molar and a mass basis, (b) the percent of theoretical air, (c) the equivalence ratio, and (d) the dew point temperature of the products, in °F, if the pressure is 1 atm.	**8**	**CO 3**
8.	Explain about various fuels and classifications and their properties for better combustion process, also explain about industrial applications	**8**	**CO 1**
9.	A mixture is composed of the following number of moles of various species: Determine the mole fraction of nitric oxide (NO) in the mixture. Also, express your result as mole percent, and a parts per million (b).Determine the molecular weight of the mixture (c) Determine the mass fraction of each constituent		**CO 3**
	Derive the method by which adiabatic flame temperature is estimated for a given mixture. How does the adiabatic flame temperature vary with an increase in initial pressure?		
10.	Determine the Detonation pressure for a gaseous mixture of H_2 and O_2 for a particular mixture ratio, when this mixture at initial pressure of 0.2 MPa and 300 K is increased its density by three times due to formation of detonation wave. Assume the ideal gas law when the specific heat ratio is 1.25. Assume that the product contains only gaseous H_2O molecules. (OR)	**8**	**CO 5**
	Explain the combustion mechanism of premixed diffusion flames with the examples. Also Explain Lean and reach mixtures effects on Bunsen Burner Flames		

Species	No of moles
CO	0.095
CO_2	6
H_2O	7
N_2	34
NO	0.005

Section C (Attempt ALL questions) (2 X 20M =40 Marks)			
11.	(a). Natural gas fired boiler operates with excess air such that O_2 concentration in the flue gas after removal of moisture is 2 percent by volume. The flue gas temperature is 700 K and the fuel and air enter the boiler at 298 K. Determine (a) Air-Fuel ratio and (b) the thermal efficiency of the boiler. (b). 1 mole of CO is mixed with 1 mole of water vapor at 298 K and 1 atm pressure. The mixture is heated to 1800Kat constant pressure. Calculate the heat required and the final composition of the mixture (OR)	**20**	**CO3, CO4**
	A small, low emission, stationary gas turbine engine operates ta 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 is $C_{1.16}H_{4.32}$. Determine the fuel mass flow rate and the operating air fuel ratio of the engine.		
12.	(a). Describe the procedure for determination of Equilibrium composition with the possible species H_2, O_2, O, H, OH, H_2O. Explain the steps for formulation of equilibrium constant K_p? (b). Three Moles of Hydrogen are reacted with one mole of oxygen at ambient temperature and pressure with the following reaction $3H_2+O_2$ ---------→ $H_2+O_2+H_2O+H+O+OH$	**20**	**CO 5**