Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Combustion & Reactive Flows **Semester: II**
Program: M.Tech (CFD) **Time 03 hrs.**
Course Code: ASEG7027 **Max. Marks: 100**
Instructions: All questions are compulsory. Assume data if missing.

SECTION A

S. No.		Marks	CO
Q 1	What do you mean by combustion? Why is it important today?	**04**	**CO1**
Q 2	Why is the gaseous fuel being preferred over solid or liquid fuel in recent times? Explain with few examples.	**04**	**CO1**
Q 3	Define activation energy. Why is it so important?	**04**	**CO3**
Q 4	How does the burning velocity vary with pressure for methane-air premixed flame?	**04**	**CO4**
Q 5	What is the mechanism of soot formation in a diffusion flame? Describe it briefly.	**04**	**CO4**

SECTION B

Q 6	Determine the air-fuel ratio of ATF fuel (C_8H_{18}) for an equivalence ratio of 0.5. The higher heating value for the aviation turbine fuel (ATF) is 48,000 kJ/ Kg at 298K. The heat of vaporization of this liquid fuel is 375 kJ/kg. Calculate the heat of reaction at 298 K for the ATF vapour.	**10**	**CO3**
Q 7	Derive Ficks law of diffusion from the basic principle. What are the commonalities among three transport laws?	**10**	**CO2**
Q 8	Explain the phenomena of flashback and blow-off? How can this be related to the burning velocity?	**10**	**CO4**
Q 9	A liquid fuel combustor is to be designed, considering the flow to be one-dimensional with mono-dispersed spray of initial droplet diameter of 200 μm. The initial air velocity is 2.0 m/s at 600K and 0.1 MPa. The fuel/air ratio by mass is estimated to be 0.06 with adiabatic flame temperature of 2100K. Assume burning rate constant to be 0.9 mm^2/s. The density of liquid fuel is 800 kg/m^3. Determine the initial droplet number density the length of the reaction zone and the combustion intensity. Take C_p= 1.2 kJ/kg K. **OR** Illustrate D^2 law? What is its significance as far as combustion of droplet is concerned? Is it valid for solid fuel combustion?	**10**	**CO4**

SECTION-C			
Q 10	Apply Chapman-Jouguet condition to illustrate DDT model in gas turbines. Analyze the Zeldovich-Von Neumann-Doring (ZND) theory of detonation.	**20**	**CO5**
Q 11	Analyze the methods available for SO_x and CO_x emission control with relevant schematic diagrams. Which method is preferred most? Why is it so? **OR** In a laboratory, combustor methane fuel is burnt at fuel lean condition and 200 ppm of CO concentration (dry) is measured by Non-Dispersive Infra-Red (NDIR) gas analyzer at 7.5% of oxygen level. Calculate the CO level at 15% oxygen level?	**20**	**CO5**

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SECTION A

S. No.		Marks	CO
Q 1	Illustrate the scope of combustion in modern times.	**04**	**CO1**
Q 2	What is Schmidt Number? Where it can be useful?	**04**	**CO3**
Q 3	How does the reaction rate of methane-air mixture vary qualitatively with temperature?	**04**	**CO3**
Q 4	What do you mean by flammability limits? How does it vary with increase in initial temperature of the mixture?	**04**	**CO4**
Q 5	Under what condition one can produce under-ventilated and over-ventilated diffusion flame.	**04**	**CO4**

SECTION B

Q 6	Methane is burnt in a combustor with air-fuel ratio of 20. Determine the equivalence ratio. If the air is replaced with 20% of N_2, estimate the equivalence ratio and fuel-oxygen ratio.	**10**	**CO2**
Q 7	Draw hydrodynamic and thermal boundary layer for flow over isothermal flat plate; (i) Pr<1, (ii) Pr=1, and (iii) Pr>1. Comment on your results.	**10**	**CO3**
Q 8	What do you mean by quenching diameter? How it will be useful for a LPG application?	**10**	**CO4**
Q 9	An hexane (C_6H_{14}) fuel droplet diameter of 200μm is burnt in combustor (P=0.1 MPa, T_∞= 1300 K). Determine the lifetime of a single droplet. **OR** What is the lifetime of a droplet during its burning? Derive an expression for this. What are the parameters that govern droplet's lifetime?	**10**	**CO5**

SECTION-C

Q 10	Briefly describe the Pulse Jet Engine (PDE). Analyze the cycles involved in Pulse Detonation Engine. What are the challenges faced by design engineers in developing PDE.	**20**	**CO5**
Q 11	What is Diffusion Flame? Analyze the two-dimensional (2D) diffusion flame using	**20**	**CO4**

	Burke-Schumann’s jet diffusion model. Briefly explain the assumptions considered in the model. **OR** A laminar butane gas jet issued from a tube into the air has a flame height of 10 cm. Determine volumetric fuel flow rate and heat release rate. If the fuel tube diameter is increased by 25% and the velocity is increased by 25%, calculate the flame height using Burke-Schumann’s jet diffusion flame model. Take heat of combustion of butane gas=45,000 kJ/kg, T_{ad}=2300K.		