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

**Autonomous Institute Affiliated to VTU**

## September / October 2023 Supplementary Examinations

**Programme: B.E.** **Semester: VI**
**Branch: Aerospace Engineering** **Duration: 3 hrs.**
**Course Code: 20AE6DCCOM** **Max Marks: 100**
**Course: COMBUSTION** **Date: 13.09.2023**

**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 Table is allowed.





### UNIT - I

| | | | |
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| 1 | a) | The gasoline ($C_8H_{18}$) is burnt with dry air. The volumetric analysis of products on dry basis is $CO_2$ = 10.02 %, $O_2$ = 5.62 %, CO = 0.88% and $N_2$=83.48%. Determine i) A/F ratio ii) equivalence ratio and % stoichiometric air used. | **10** |
| | b) | What are the various factors affecting the adiabatic flame temperature? Briefly explain. | **6** |
| | c) | Define standardized enthalpy and heat of reaction. | **4** |

**OR**

| | | | |
|---|---|---|---|
| 2 | a) | Consider the water gas shift reaction $H_2O$ (l) + CO (g) $\longrightarrow$ $H_2$ (g) + $CO_2$ (g). Determine the equilibrium constant for the reaction at 298 K, treating the gaseous species as ideal. | **8** |
| | b) | Calculate the adiabatic flame temperature for hydrogen-air mixture at 1 atm pressure and the initial reactant temperature is 298 K. Take Cp of $H_2O$ and $N_2$ as 43 kJ /kg-mol K and 34 kJ /kg-mol K respectively. | **8** |
| | c) | Define the following i) heat of formation ii) heat of combustion. | **4** |

### UNIT - II

| | | | |
|---|---|---|---|
| 3 | a) | What are the commonalities among the three transport laws? | **6** |
| | b) | Explain the various elementary reaction by taking suitable example. | **8** |
| | c) | Derive an expression for species conservation equation. | **6** |

### UNIT - III

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|---|---|---|---|
| 4 | a) | What is the difference between the deflagration and detonation? In week deflagration problems pressure variations can be neglected, while in strong detonation or weak detonations pressure variations need to be taken into | **10** |

account. Can you explain why this is so based on the Rankine-Hugoniont curves?

b) In a premixed flame, natural gas burning with air, explain the intensity (flame region) distribution of the flame. Take the height of the flame as z, and radius of the tube as r or dia of the tube 'd'. Explain the intensity of distribution (I) at different locations, z/d=0.1, z/d = 0.85 and z/d = 1.4 and at r/d = 0 (centre, peak). Try to plot Intensity distribution along the radius at three axial locations of the flame (I vs r/D). **6**

c) Explain the features of propagating flame and stationary flame. **4**

**OR**

5 a) Calculate the 'q' for a gaseous stoichiometric mixture of CO and $O_2$. Assume the only products is $CO_2$. Calculate the detonation pressure if the initial state is at $P_1$ = 1 bar, $\rho_1$ = 1 kg/$m^3$, and the final state is $\rho_2$ = 3 kg/$m^3$ .Assume $\gamma$ = 1.4. Also calculate the C.J detonation speed. **10**

b) Why the study of flame speed is important? **4**

c) What is the mechanism by which flame is stabilized in the bunsen burner? Use necessary sketches. **6**

**UNIT - IV**

6 a) What is $D^2$ law? **4**

b) Explain the candle burning with different zones. Use necessary sketches and highlight its temperature distribution. **6**

c) Derive an expression for quenching diameter and highlight its significance. **10**

**UNIT - V**

7 a) Calculate the $CO_2$ emissions for the fuels below and which one among them is better in terms of $CO_2$ emissions. Take wood as $CH_{1.4}O_{0.6}$, LPG (80% butane and 20 % Propane) and Petrol, assuming stoichiometric combustion with air. **6**

b) What are the various NOx reduction methods? Explain briefly use necessary sketches. **10**

c) How does emissions from the combustion systems affect human health? **4**

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