

B.E. Power Engineering, 4th Year, 2nd Semester Examination, 2024**Combustion****Time: Three Hours****Full Marks: 100****Group A: CO1 (30 Marks)**

1. Answer the following questions briefly (any four questions)
 - a) Define heterogeneous reaction during combustion. Give an example.
 - b) What do you mean by order of reaction? State its physical significance.
 - c) What do you mean by the termolecular reaction? State its physical significance.
 - d) What is the equivalence ratio in a combustion system? State its physical significance.
 - e) What is the enthalpy of formation? State its physical significance.

Marks: $4 \times 4 = 16$

2. Answer the following question (any one question)
 - a) The products of combustion of a saturated aliphatic hydrocarbon fuel of unknown composition have 8% CO₂, 0.9% CO, 8.8% O₂ and 82.3% N₂ measured on volumetric dry air basis. Calculate the actual air-fuel ratio, composition of the fuel and the % theoretical air.
 - b) Consider the reaction $A + B \rightarrow C$, where the rate law is given as $\frac{d[X_A]}{dt} = -k[X_A]^2[X_B]^0$, where $k = 0.1 \text{ m}^3/\text{kmol}\cdot\text{s}$. In the initial mixture, the concentrations of A and B are 2 kmol/m³ and 5 kmol/m³, respectively with no C. What will be the concentration of A, B and C after 5 sec?

Marks: $1 \times 16 = 16$ **Group B: CO2 (20 Marks)**

3. Answer the following questions briefly (all questions)
 - a) For a Cartesian coordinate system, derive the following expression for the conservation of species:

$$\frac{\partial y_i}{\partial t} + (v_x \frac{\partial y_i}{\partial x} + v_y \frac{\partial y_i}{\partial y} + v_z \frac{\partial y_i}{\partial z}) = \rho \left(\frac{\partial^2 y_i}{\partial x^2} + \frac{\partial^2 y_i}{\partial y^2} + \frac{\partial^2 y_i}{\partial z^2} \right) + \dot{m}_i'''$$
 where symbol denotes the usual notations, ρ is the diffusion coefficient, \dot{m}_i''' is the generation of i^{th} species per unit volume per unit time.
 - b) What do you mean by flame quenching and blowout in a premixed flame of gaseous fuels? State its physical significance.
 - c) Briefly write down the description of a pre-mixed gaseous flame. What is flame lift-off and blowout?

Marks: $12 + 3 + 5 = 20$ **Group C: CO3 (15 Marks)**

4. Answer the following questions briefly (any three questions)
 - a) Briefly describe about the atomizers and their performance including applications.

[Turn over

- b) What are the factors that influence the Atomization process?
- c) Considering a one-film simplified model, describe about the char particle reactions process (use temperature and species distribution diagram).
- d) Describe about the kinetically controlled, and diffusion-controlled burning process of carbon particles.

Marks: $3 \times 5 = 15$

Group D: CO4 (15 Marks)

5. Answer the following questions briefly (any two questions)
- a) Describe about the spray combustion process.
 - b) Briefly describe about the corner-fired pulverized coal-burning process.
 - c) Briefly describe about the different applications of the combustion process.

Marks: $2 \times 5 = 10$

Group E: CO5 (20 Marks)

6. Answer the following questions briefly (any two questions)
- a) Briefly describe about the combustion emissions and their control strategy.
 - b) Briefly describe about the emission of particulate matter and their control strategy.
 - c) Briefly describe about the control of CO₂ emission.

Marks: $2 \times 10 = 20$