Birla Institute of Technology and Science, Pilani – Pilani Campus
Semester-II, 2021-22
Mid-Semester Examination (Regular – Closed Book)
CHE G641: Reaction Engineering

Date: 9/3/2022 **Marks: 30** **Duration: 90 min.**

Instructions:
i) Attempt all the questions.
ii) Each question carries 5 marks.
iii) Answer each question on a new page.
iv) Take suitable assumptions wherever necessary.

1. Cite the differences between homogeneous and heterogeneous reactions. Give three industrially important examples of catalytic and non-catalytic heterogeneous reactions, clearly mention the phase of reactants, products and catalyst involved in the reaction.
2. How would you determine experimentally if a given reaction is film control, ash control or reaction control?
3. Enlist the rates steps involved in a slurry reactor. Draw a neat schematic showing all the resistances that are involved along with the concentration profile of reactants.
4. What do you understand by micro-fluid and macro-fluid? Write the design equation for macro-fluid for ideal contacting in (i) plug flow reactor; (ii) mixed flow reactor. Comment on the kinetic behavior of both the fluids when passed through each reactor respectively.
5. Derive an expression relating time, conversion and radius for type-A reaction using shrinking core model for a non-porous solid. State all the assumptions clearly.
6. The spherical particles of pure B of radius 6 mm are added to a rotary calciner to be heated to react. The gas component reacting with the solid is uniformly distributed in the furnace. The whole process can be considered as an isothermal. It is a first order irreversible reaction for A, and the reaction is conducted according to the following stoichiometric equation:

   $$A(g) + B(s) \rightarrow rR(s) + sS(g)$$

   B is dense and the product layer is porous. In the furnace, the solid moves at a speed of 2.5 mm/s from the inlet to the outlet in a plug flow. The effect of the external diffusion is negligible. In a batch stirred tank, at the same gas composition and temperature, the following data are obtained:

Particle Radius, mm	Reaction Time, h	Conversion of B, X_B (%)
3	1.0	87.5
6	2.0	65.7

   If the required conversion at the outlet of the rotary calciner, x_B=90%, please calculate the required furnace length.
   Data (if required): C_A=0.015 kmol/m^3; ρ_B=18 kmol/m^3.

*****The End*****