Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2019

Programme Name: M. Tech CE + PD **Semester : I**
Course Name : Chemical Reactor Engineering and Design **Time : 03 hrs**
Course Code : CHPD7004 **Max. Marks: 100**
Nos. of page(s) : 02

Instructions: 1) Answer the questions section wise in the answer booklet. 2) Assume suitable data wherever necessary. The notations used here have the usual meanings.

SECTION A (Total Marks: 3 x 10 = 30)

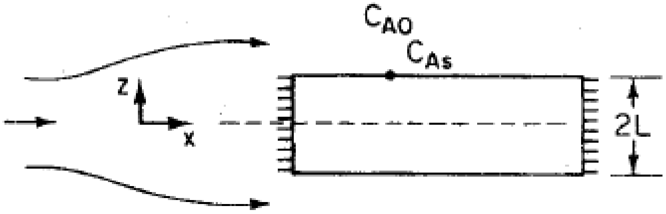
- Attempt ***all*** the questions. All questions carry equal marks.

<table>
<tr><th>S. No.</th><th></th><th>Marks</th><th>CO</th></tr>
<tr><td>Q 1</td><td>Explain the Tanks-in-Series model to describe nonideal reactors and calculate conversion.</td><td>10</td><td>CO2</td></tr>
<tr><td>Q 2</td><td>The exothermic reaction $A \rightarrow B + C$ was carried out adiabatically and the following data recorded.
<table>
<tr><td>X</td><td>0</td><td>0.2</td><td>0.4</td><td>0.45</td><td>0.5</td><td>0.6</td><td>0.8</td><td>0.9</td></tr>
<tr><td>$-r_A$ (mol/dm^3.min)</td><td>1.0</td><td>1.67</td><td>5.0</td><td>5.0</td><td>5.0</td><td>5.0</td><td>1.25</td><td>0.91</td></tr>
</table>
The entering molar flow rate of A was 300 mol/min.
a) Calculate the volume of a CSTR needed to achieve 40% conversion
b) Over what range of conversions would the CSTR and PFR volumes be identical?</td><td>10</td><td>CO1</td></tr>
<tr><td>Q 3</td><td>Write down an algorithm for the design of an isothermal CSTR carrying out a liquid phase reaction where the rate of reaction is not given explicitly as a function of conversion.</td><td>10</td><td>CO2</td></tr>
</table>

SECTION B (Total Marks: 3 x 15 = 45)

- Attempt ***all*** the questions. All questions carry equal marks.

Q 4	a) What are the steps involved in the heterogeneous catalytic reactions? b) Discuss about the mechanisms involved for the surface reaction to occur after a reactant has been adsorbed onto the surface.	**07** **08**	**CO3**
Q 5	a) Derive an expression for the diffusion of A (concentration profile) through a film to catalyst particle. b) Discuss about the regions of mass transfer-limited and reaction-limited reactions.	**10** **05**	**CO3**

Q 6	The irreversible reaction $A \rightarrow B$ is taking place in the porous catalyst slab as shown in Fig.1. The reaction is zero order in A. Show that the concentration profile using the symmetry B.C. is $\frac{C_A}{C_{As}} = 1 + \phi_0^2 \left[\left(\frac{z}{L} \right)^2 - 1 \right]$ where $\phi_0^2 = \frac{kL^2}{2D_e C_{As}}$  Fig. 1 Flow over porous catalyst slab.	15	CO4
SECTION-C (Total Marks: 1 x 25 = 25)			
Q 7	a) A liquid phase reaction $A + B \rightarrow C$ follows an elementary rate law and takes place in a 1 m^3 CSTR, to which the volumetric flow rate is 0.5 m`/min and the entering concentration of A is 1 M. When the reaction takes place isothermally at 300 K with an equal molar feed of A and B, the conversion is 20%. When the reaction is carried out adiabatically, the exit temperature is 350K and the conversion is 40%. The heat capacity of A, B and C are 25, 35 and 60 J/mol.K, respectively. What is the rate of heat removal necessary for isothermal operation. b) Write down the design equations for a fixed bed reactor along with boundary conditions. c) Explain about the bubbling fluidized bed reactor.	**07** **08** **10**	**CO2** **CO4** **CO5**