Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, January 2021

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. 3) The notations used here have the usual meanings.

SECTION A (Total Marks: 6 x 5 = 30)

- Attempt ***all*** the questions.

S. No.		**Marks**	**CO**
Q 1	Write down the assumptions of a CSTR.	**5**	**CO1**
Q 2	Discuss about the internal effectiveness factor and overall effectiveness factor.	**5**	**CO2**
Q 3	How do you determine the rate limiting step in heterogeneous catalysis?	**5**	**CO3**
Q 4	How do you consider the molar flux term in case of equimolar counter-diffusion?	**5**	**CO4**
Q 5	Explain in brief about the working of a slurry reactor and its applications.	**5**	**CO5**
Q 6	How modeling of a bioreactor is different from a chemical reactor?	**5**	**CO5**

SECTION B (Total Marks: 5 x 10 = 50)

- Attempt ***all*** the questions.

<table>
<tr><td>Q 7</td><td>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?</td><td>10</td><td>CO1</td></tr>
<tr><td>Q 8</td><td>A sample of the tracer hytane at 320 K was injected as a pulse to a reactor and the effluent concentration was measured as a function of time. The resulting data is shown below.
<table>
<tr><td>Time, min</td><td>0</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td><td>12</td><td>14</td></tr>
<tr><td>Concentration (g/m^3)</td><td>0</td><td>5</td><td>10</td><td>6</td><td>3</td><td>1.5</td><td>0.6</td><td>0</td></tr>
</table>
Calculate the mean residence time for the reactor by the RTD obtained from a pulse input at 320 K.</td><td>10</td><td>CO2</td></tr>
<tr><td>Q 9</td><td>Discuss the steps involved in the catalytic reaction.</td><td>10</td><td>CO3</td></tr>
</table>

Q 10	Derive an expression for a diffusion through a film to a catalyst particle.	**10**	**CO3**
Q 11	Explain about the K-L model used for a bubbling fluidized bed with a neat sketch.	**10**	**CO5**
SECTION-C (Total Marks: 1 x 20 = 20)			
Q 12	What is a fixed bed reactor? Establish the mathematical equations in fluid and solid phases to design a fixed bed reactor along with boundary conditions. State the assumptions clearly.	**20**	**CO4**