

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION, MO2025)

CLASS: B. TECH  
BRANCH: CHEMICAL ENGINEERING

SEMESTER: VII<sup>th</sup>  
SESSION: MO/2025

SUBJECT: CL429 CHEMICAL PROCESS INTENSIFICATION

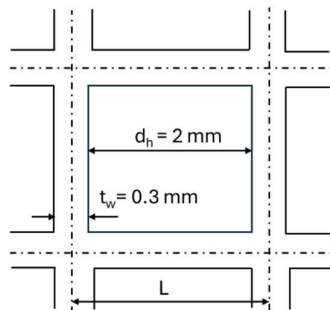
TIME: 3 Hours

FULL MARKS: 50

**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

		CO	BL
Q.1(a) Explain the principles of the Rotating Packed Bed reactor with a schematic diagram.	[5]	1	2
Q.1(b) What are the limitations of using a packed bed reactor in the tail pipes of automobiles? How does an intensified monolith reactor overcome the limitations?	[5]	4	2
Q.2(a) What are the typical flow regimes of gas/liquid two-phase flow? Which flow regime is preferable for the operation of a monolith and a microreactor, and why?	[5]	4	2,3
Q.2(b) It is desired to absorb CO <sub>2</sub> (15% by volume) from a gas stream flowing at 10 Nm <sup>3</sup> /h (fairly high flow rate). Traditionally, a packed-bed reactor is a natural candidate. However, based on discussions in lectures, propose a sustainable strategy to intensify the process.	[5]	2	
Q.3(a) Hydrogen is conventionally produced in reformers through endothermic steam methane reforming (SMR) reactions on Ni/Al <sub>2</sub> O <sub>3</sub> . The following are the typical reactions $CH_4 + H_2O \leftrightarrow CO + 3H_2, \Delta H = 206.1 \text{ kJ/mol}$ $CO + H_2O \leftrightarrow CO_2 + H_2, \Delta H = -41.15 \text{ kJ/mol}$ $CH_4 + 2H_2O \leftrightarrow CO_2 + 4H_2, \Delta H = 165.0 \text{ kJ/mol}$	[5]	2	3
Which among the following - microreactors, cavitation reactors, monolith, reactive distillation unit, and a rotating packed bed will be a suitable candidate to intensify the hydrogen production using SMR reactions? Justify			
Q.3(b) Describe how the production of Methyl Tertiary Butyl Ether (MTBE) from Methanol and Isobutene can be intensified through Reactive Distillation?	[5]	5	1,2
Q.4(a) How is intensification achieved in microreactors? Explain with an example	[5]	4	2
Q.4(b) The schematic of a monolith channel of 600 cpsi with a thickness of ( $t_w$ ) and channel width of ( $d_h$ ) is shown below.	[5]	4	4



Calculate:

- (i) Geometric Surface Area (GSA)
- (ii) Open Frontal Area (OFA)
- (iii) Diffusion length ( $l_d$ ) of 'washcoated' catalyst

Given:  $GSA = 4 \frac{(L-t_w)}{L^2}$ ,  $OFA = \frac{(L-t_w)^2}{L^2}$

Q.5(a) Explain the benefits of hydrodynamic cavitation with an application.	[5]	3	2
Q.5(b) What drives mixing in microchannels? Explain with relevant dimensionless numbers	[5]	4	2,3