# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: PG**

**Branch: Computer Aided Process Design**

**Subject Code: ME02072021**

**Subject Name: Advanced Reaction Engineering And Kinetics**

| | |
|---|---|
| w. e. f. Academic Year: | 2024-25 |
| Semester: | 2 |
| Category of the Course: | Professional Core Course |

| | |
|---|---|
| **Prerequisite:** | Basics of reaction engineering and fundamentals of computational tools |
| **Rationale:** | This course covers complex reaction systems and reactor design, integrating both theoretical concepts and computational tools. Topics include heterogeneous reactions i.e. fluid-particle, fluid-fluid; fluidized bed reactors; bubble column reactors and multiphase reactors (slurry, trickle bed, moving bed). It also addresses biochemical reaction engineering and catalytic reactions. The course emphasizes reactor design using computational tools to optimize reactor performance and efficiency across various systems. |

**Course Outcomes:**

After Completion of the Course, Student will able to:

| No. | Course Outcomes | |
|---|---|---|
| 1 | To interpret the importance of heterogeneous reactions. | R, U |
| 2 | To demonstrate designing of fluidized bed reactor and bubble column reactors. | U, A |
| 3 | To explain fundamentals of multiphase reactors. | U, A |
| 4 | To apply basics of catalysis for designing the catalytic reactors. | A |

| **Teaching and Examination Scheme** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Total Credits L+T+ (PR/2)** | **Assessment Pattern and Marks** | | | | **Total Marks** |
| **L** | **T** | **PR** | **C** | **Theory** | | **Tutorial / Practical** | | |
| | | | | ESE (E) | PA / CA (M) | ESE (V) | PA/CA (I) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

**Course Content:**

| Unit No. | Content | No. of Hours | % of Weightage |
|---|---|---|---|
| 01 | **HETEROGENEOUS REACTIONS:** Introduction, Classification, Examples of Heterogeneous reaction, Rate expressions<br>Fluid-Particle Reactions, Different Types of Models, Stoke's Regime, Determination of Rate controlling steps<br>Fluid-Fluid Reactions, Rate equation, Kinetic regimes for mass transfer and reaction, Rate equation for Different Kinetic regimes | **10** | **20** |
| 02 | **FLUIDIZED BED REACTORS:** Basics of fluidization, types of fluidizations, flow pattern, Reaction kinetics, Performance equation, Design equation for fluidized bed reactor, Different Models for fluidized bed reactor, Hydrodynamic flow model, Bubbling Fluidized bed reactor, Design of fluidized bed reactors: Design for physical operation, catalytic and noncatalytic systems**,** Mass and Heat transfer phenomena in fluidized bed reactor, Use of computational tools for designing | **10** | **20** |
| 03 | **BUBBLE COLUMN REACTOR:** Bubble column Reactor-Introduction, Various factors affecting the performance of Bubble column Reactor, Industrial Applications, Advantages and disadvantages of Bubble column reactor, Criteria of selection of different types of gas-liquid reactors, Process design of Bubble column reactor, Example of Bubble column reactor, Use of computational tools for designing | **06** | **15** |
| 04 | **MULTIPHASE REACTORS:** Design of Multiphase Reactor, Slurry Reactor-Slurry Reaction kinetics, Performance equation, Applications. Trickle bed reactors- basics, kinetics, design equations, applications, Loop Reactor- Introduction, and Field Applications, Moving bed reactor- performance equation, characteristics, application etc. Use of computational tools for designing | **08** | **20** |
| **05** | **BIOCHEMICAL REACTION ENGINEERING:** Types of Bio reactors, Selection of reactor, Design, Scale up, Operation and Control of Bio Reactors, Kinetics of Bio-Chemical reactions | **05** | **10** |
| **06** | **CATALYTIC REACTIONS:** Catalyst, steps in catalytic reactions | **06** | **15** |

| | | | |
|---|---|---|---|
| | and its kinetics, Adsorption Kinetics: rate of adsorption and desorption, Reaction mechanism: Power law model, LHHW model, Eley Rideal model; Design of catalytic reactors, Photocatalysis-basics and applications | | |
| | **Total** | **45** | **100** |

**Suggested Specification Table with Marks (Theory):**

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| 15 | 30 | 25 | 15 | 10 | 5 |

*Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)*

**References/Suggested Learning Resources:**

**(a) Books:**

1) Levenspiel O, Chemical Reaction Engineering, Wiley, 1998
2) Fogler,H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India, 2008
3) Schmidt L D., The Engineering of Chemical Reaction, 2nd Edition, Oxford University Press, 2005
4) J. M. Smith , Chemical Engineering Kinetics, McGraw-Hill Book, 1981
5) Inamdar S T A., Biochemical Engineering- Principles and Concepts, Prentice Hall of India, 2007.

**(b) Open-source software and website:**

1. NPTEL lecture series.

**Suggested Course Practical List: I**

1) Synthesis of catalyst using various methods and its characterization.
2) Applications of catalyst in various process/ treatments.
3) Hydrolysis of starch to glucose using gluxoamylase alpha amalyse.

4) Effect of parameters on fluidization.
5) Experiment on fluidized bed reactor.
6) Design of various reactors in computational tools.
7) Problem solving using various tools.

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