PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Chemical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Instrumentation & Process Control (03103351)

Type of Course: BTech

Prerequisite: Basics of differential equations, material and energy balance.

Rationale: This course introduces dynamic processes and the engineering tasks of process operations and control. Subject covers modeling the static and dynamic behavior of processes; control strategies; design of feedback, feed forward, and other control structures; and applications to process equipment.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
4	0	2	5	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Linear Open-Loop Control Systems:**: Response of first-order systems, physical examples of first-order systems, response of first-order systems to various inputs, first-order systems in series, higher-order systems: second-order and transportation lag.	13%	6
2	**Linear Closed-Loop Control Systems:**: Control system, closed-loop transfer functions, stability, root locus, introduction to frequency response.	12%	5
3	**Controllers and Final Control Elements:**: Controllers, final control elements, control valves.	12%	4
4	**Computers in Control System**: Introduction to microprocessor based controllers, distributed control system (DCS), programmable logic control (PLC), supervisory control and data acquisition (SCADA).	15%	5
5	**Elements of Measurement Instruments:**: Types of measurement, classification of instrument, parts of instruments, performance characteristics.	12%	4
6	**Measurement of Temperature**: Temperature scales, solid, liquid and gas expansion thermometers, filled system thermometers, electrical temperature sensors, thermistor, thermocouple, pyrometers, etc.	12%	4

7	**Measurement of Pressure:**: Elastic pressure transducers, electrical transducers, inductance type pressure transducers, forced balanced pressure gauge, measurement of differential pressure, vacuum measurement, techniques for protection of pressure gauges, comparison of pressure sensors	12%	6
8	**Measurement of Level:**: Direct level measurement, indirect level measurement methods like hydrostatic, electrical capacitance, radiation, ultrasonic, solid level measurement	12%	3

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Process systems analysis and control (TextBook)
   1. Donald R. Coughanowr,; McGraw Hill publications
2. Industrial Instrumentation
   Donald P Eckman; John Wiley & Sons Inc. Publications
3. Chemical Process Control: An Introduction to Theory and Practice,
   George Stephanopoulos; PHI Learning
4. Process Instrumentation and Control,
   A. P. Kulkarni; Nirali Prakashan

Course Outcome:

After Learning the course the students shall be able to:

- Compare open and closed loop control systems
- Apply appropriate instruments for various applications in chemical plant
- Analyze the order of control system with its transfer function
- Evaluate the performance of control system with controllers and control valve
- Design control loops with appropriate controllers and control valve

List of Practical:

1. **On-Off Controller**
2. **Characteristics of Control Valve**
3. **First Order Dynamics**
4. **Level Measurement by Air Purge Method**
5. **Responce of First Order to Step Input**
6. **Responce of First Order to Impulse Input**
7. **Responce of Non-Interacting Tank to Step Input**
8. **Responce of Interacting Tank to Step Input**

9. **Responce of Second Order to Step Input**

10. **Linear Variable Diffrential Transducer**

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Chemical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Chemical Reaction Engineering-I (03103352)

Type of Course: BTech

Prerequisite: Chemical reaction engineering is that engineering activity concerned with the exploitation of chemical reactions on a commercial scale. Its goal is the successful design and operation of chemical reactors, and probably more than any other activity it sets chemical engineering apart as a distinct branch of the engineering profession.

Rationale: This subject introduces concepts of reaction rate, derivation of rate expressions from reaction mechanism, ideal reactor types, integral method of analysis, differential method of analysis, principles of chemical reactor analysis and design, experimental determination of rate equations, design of batch and continuous reactors, how to choose the most appropriate reactor for a given feed, optimization of selectivity in multiple reactions, consideration of temperature and pressure effects, etc.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	2	4	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Kinetics of Homogeneous Reactions:**: Introduction to chemical kinetics,classification of reactions, variables affecting reaction rate, concentration dependent term of rate equation, temperature dependent term of rate equations, testing kinetic models, Arrhenius theory, collision theory, comparison of theories.	4%	7
2	**Interpretation of Batch Reactor Data:**: Integral and differential methods of analysis of data for constant volume and variable volume cases, searching a rate equation and mechanism to fit experimental data.	8%	15
3	**Introduction to Reactor Design:**: Mass and energy balances for steady state and unsteady state reactors	12%	23
4	**Reactor Design for Single Reactions:**: Batch reactor, plug flow reactor, mixed flow reactor and their comparison. multiple reactor system, plug flow reactors in series, mixed flow reactors in series, reactors of different types in series, recycle reactors and auto catalytic reactions.	8%	15

5	**Design for Multiple Reactions:**: Series, parallel and complex reactions, contacting patterns and product distribution.	4%	7
6	**Temperature and Pressure Effects:**: Heat of reaction and equilibrium constants, optimum temperature progression.	4%	7
7	**Non-ideal Flow Behaviour:**: Basics of non-ideal flow, concept of residence time distribution (RTD), degree of segregation, earliness/lateness of mixing.	7%	13

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Chemical Reaction Engineering (TextBook)
   Octave Levenspiel; Third Edition, John Wiley and Sons
2. Elements of Chemical Reaction Engineering
   H. Scott Fogler,; Prentice Hall
3. Chemical Engineering Kinetics,
   J. M. Smith; McGraw-Hill.
4. Chemical Reactor Analysis and Design,
   Gilbert F. Froment and Kenneth B. Bischoff; John Wiley & Sons.

Course Outcome:

After Learning the course the students shall be able to:

• Relate homogeneous reactions with their kinetic mechanisms
• Utilize the concept of residence time distribution for real reactors
• Develop rate expressions for homogeneous reactions
• Analyze the effect of change in reaction parameters on the rate of desired product formation
• Propose suitable reactor for single and multiple homogeneous reactions

List of Practical:

1. **Overview of Chemical Reaction Engineering**
2. **The Kinetics of Reaction and Order of Reaction**
3. **Kinetics Studies in Continuous Stirred Tank Reactor**
4. **Determination of Activation Energy**
5. **Determination of Frequancy Factor**
6. **Differential method of Analysis**
7. **Integral Metod of Analysis**
8. **Kinetics by Half Life method in a Stirred Cell**

9. **Pseudo-First Order Kinetics**

10. **The Kinetics Non-Elementary Reaction**

11. **Decomposition of Hydrogen Peroxide**

12. **Temperature Dependency of Reaction Rate**

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Chemical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Process Equipment Design (03103353)

Type of Course: BTech

Prerequisite: The student should have basic understanding of Unit Operations of Chemical Engineering.

Rationale: Equipment design involves modifications and additions to existing plants or creating design layouts of plant / equipments. With rapid rate of increase in the advancement of knowledge, it is important that the students should know the relevant application for equipment design. It has been observed conclusively that practice in using the reference literature and software has helped the students to secure jobs and also to perform better in profession.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
4	0	2	5	60	30	20	20	20	150

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Introduction to Process Equipment Design**: Criteria and factors for design, need for design, basic considerations in equipment design, materials selection and protective coating, selection criteria of the particular separation methods or equipment, nature of design, types of process, codes and standards, factor of safety, degree of freedom and design variables.	5%	4
2	**Design of Decanter and Cyclone Separator**:	10%	4
3	**Process design of Heat exchangers:**: Shell & Tube heat exchangers, Functions of various parts of shell & Tube Heat exchanger, General design method of shell & tube heat exchanger, Criteria of selection among Fixed Tube sheet, U Tube & Floating Head heat exchanger, Process design of without phase change heat exchanger.	15%	8
4	**Process design of Distillation Column:**: Introduction, Criteria of selection, Selection of equipment for distillation, Distillation column design, Selection of key components for multi-component distillation, Determination of operating pressure for distillation column, Advantages & disadvantages of vacuum distillation, Determination of nos. of theoretical stages for binary distillation by McCabe Thiele method	15%	8

5	**Absorption Column:**: Introduction to absorption, different types of packing and packing supports, calculation of packing height and tower diameter for packed column.	15%	8
6	**Process design of piping, Fluid moving devices and Flow meters:**: Introduction, Process design of piping, NPSHA &NPSHR, Power required by pump, evaluation of Centrifugal pump performance when handling viscous liquids, Power required in Fan, Blower and adiabatic compressor, flow meters, Process design of Orifice meter, Rotameter	10%	4
7	**Mechanical design of Pressure vessel**: Introduction to mechanical design, overview of pressure vessel, storage vessel and tall vertical vessel design, types and selection of head.	20%	8
8	**Supports :**: Different types of supports, Mechanical design of bracket support, skirt support & saddle support	10%	4

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Process Equipment Design
   M.V. Joshi; McMillan.
2. Introduction to Process Engineering and Design,
   Suchen B. Thakore and Bharat I. Bhatt,; Tata McGraw-Hill.
3. Applied Process Design for Chemical and Petrochemical Plants,
   Ernest E. Ludwig,; Vol. 2, Gulf Professional Publishing.
4. Chemical Engineering Series, Chemical Engineering Design,
   R. K. Sinnott, Coulson and Richardson's; 4th Edition, VI volume, Elsevier Publication.
5. Chemical Engineering Design (TextBook)
   Towler, Gavin and Sinnott, R. K.; Butterworth-Heinemann (2008)

Course Outcome:

After Learning the course the students shall be able to:

- Illustrate the basic design requirements of the process equipment
- Outline the design considerations for cooling tower and pumps
- Apply fundamentals of mechanical design to process equipment
- Select suitable process equipment
- Design important process equipment

PARUL UNIVERSITY - Faculty of Engineering and Technology

Department of Chemical Engineering

SYLLABUS FOR 6th Sem BTech PROGRAMME

Nanotechnology (03103380)

Type of Course: BTech

Prerequisite: The student should have basic understanding Nanotechnology

Rationale: To understand above subject knowledge of optical physics, inorganic chemistry, crystal structure of materials (Crystal Physics), and electrical and magnetic properties of materials.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	0	3	60	-	20	20	0	100

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Introduction:**: Nanoscience and nanotechnology- the distinction, significances, historical perspectives, natural and man-made nanomaterials, properties of nanomaterials.	20%	12
2	**Synthesis of nanomaterials:**: Top-down and bottom-up synthesis methods, self-assembly and sol-gel process, synthesis of carbon based and metallic nanomaterials	25%	12
3	**Characterization tools for Nanomaterials:**: Electron microscopy methods, spectroscopic methods, other important characterization methods.	25%	10
4	**Applications of Nanomaterials:**: Nanobiotechnology, micro/nano electromechanical systems, medical applications, nanomaterials for catalysis.	20%	10
5	**Societal implications of nanotechnology:**: Nanotoxicology, potential health and safety concerns of nanomaterials	10%	5

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Nanomaterials for Biosensors,
Challa Kumar,; Wiley-VCH.

2. Introduction to Nanoscience and Nanotechnology,
Gabor L Hornyak, Harry F Tibbals, Joydeep Dutta, John J Moore,; CRC Press.
3. The Essentials-Understanding Nanoscience and Nanotechnology,
T. Pradeep, Nano; McGraw-Hill Education
4. Nanotechnology in Biology and Medicine: Methods, Devices and Application,
Tuan Vo-Dinh; CRC Press
5. Nanotechnology: Importance and Application,
M.H. Fulekar,; IK International

Course Outcome:

After Learning the course the students shall be able to:

• Relate the key concepts in materials science, chemistry, physics, biology and engineering to the field of nanotechnology
• Demonstrate a conceptual knowledge of instrumentation for the characterization of nonmaterial
• Distinguish various approaches for synthesis of nonmaterial
• Assess applications of nanotechnology and societal issues that may impede the adoption of nanotechnology

PARUL UNIVERSITY - Faculty of Engineering and Technology

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SYLLABUS FOR 6th Sem BTech PROGRAMME

Separation Technique (03103381)

Type of Course: BTech

Prerequisite: Separation techniques are integral unit operation in most of the modern chemical, pharmaceutical and other process plants.

Rationale: There are many standard and conventional separation techniques available in the market and these techniques are quite common and the relevant technologies as well as well developed and well studied. On the other hand, newer separation processes, like, membrane based techniques, chromatographic separation, super critical fluid extraction, etc., are gaining importance in modern days plants.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
				External		Internal			
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		T	P	T	CE	P	
3	0	0	3	60	-	20	20	-	100

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Introduction to Separation Processes:**: Importance and variety of separations, economic significance of separation processes.	10%	8
2	**Selection of Separation Processes**: *Factors influencing the choice of a separation processes, process alternatives.*	10%	10
3	**Enhanced Distillation and Supercritical Extraction:**: Principle, methodology, applications and feasibility of extractive distillation, salt distillation, azeotropic distillation, reactive distillation and supercritical fluid extraction	25%	18
4	**Membrane Separation Techniques:**: Introduction to membrane processes, physical and chemical properties of membranes. Preparation of membranes, types of membrane modules, selection of modules, plant configurations, mechanism of membrane separation processes, membrane separation models like capillary flow theory, solution diffusion model, viscous flow models, models for separation of gas (vapour) mixtures. Membrane fouling and cleaning	14%	10

5	**Technologies:**: Principle, membranes, modules, design, selection, applications, current status and scope of following membrane based separation processes Micro filtration, ultra filtration, nano-filtration, reverse osmosis, gas permeation, pervaporation, dialysis, electro-dialysis, liquid membranes. Principle, methodology and scope of membrane contactors, membrane distillation, membrane reactors, controlled drug delivery and membranes in medical science	37%	17

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Membrane Technology and Applications (TextBook)
   1. R. W. Baker; John Wiley & Sons
2. Separation Process Principles
   J. D. Seader and Ernest J. Henley; John Wiley & Sons
3. Separation Processes
   C. Judson King; Mc-Graw-Hill
4. Mass Transfer Operations
   R. E. Treybal; Mc-Graw-Hill
5. Unit operations of Chemical Engineering
   Warren L. McCabe, Julian C. Smith, Peter Harriott; Mc-Graw-Hill
6. Transport Processes and Separation Process Principles
   Christie John Geankoplis; Prentice Hall

Course Outcome:

After Learning the course the students shall be able to:

- Relate the fundamentals of various advanced separation techniques
- Outline of membrane based separation systems
- Compare advanced separation techniques with conventional separation techniques
- Select appropriate alternative separation techniques

PARUL UNIVERSITY - Faculty of Engineering and Technology

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SYLLABUS FOR 6th Sem BTech PROGRAMME

Process Integration (03103382)

Type of Course: BTech

Prerequisite: Basics of heat transfer, mass transfer and reaction engineering

Rationale: Chemical process design requires the selection of a series of processing steps and their integration to form a complete manufacturing system. This course emphasizes selection of the steps as individual operations and their integration to form an efficient process.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
Lect Hrs/ Week	Tut Hrs/ Week	Lab Hrs/ Week		External		Internal			
				T	P	T	CE	P	
3	0	0	3	60	-	20	20	-	100

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
1	**1**: **General Aspects of Process Integration**	10%	3
2	**Targeting Methodology:**: Construction of hot composite curve, cold composite curve, problem table algorithm, grand composite curve, obtaining minimum hot and cold utility.	15%	12
3	**Network Design:**: Heuristics for pinch design, application of pinch design method for maximum energy recovery, evolution of network.	15%	12
4	**Energy Savings in Distillation:**: Heuristic for the sequencing separation columns, methods to sequence simple distillation columns, operational improvements for energy savings in distillation columns, heat integration of distillation columns, appropriate placements of distillation columns, grand composite curves, heat integration characteristics of distillation, various alternatives for heat integrations of distillation columns.	20%	6
5	**Reactor Integration:**: Heat integration characteristics of reactors, appropriate placement of reactors.	15%	6
6	**Mass Exchanger Networking:**: Fresh water & waste water minimization for fixed contaminant processes and fixed flow rate processes, hydrogen network synthesis.	15%	5

7	**Introduction to Scheduling of Batch Processes:**: GANTT charts, production schedule for single products, production schedule for multiple products.	10%	3

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

Reference Books:

1. Systematic Methods of Chemical Process Design (TextBook)
   Bigler L.T., Grossman I. E., Westerberg A. W.; PHI
2. Chemical Process Design and Integration
   Robin Smith; John Wiley and Sons
3. Heat Exchanger Network Synthesis
   U. V. Shenoy; Gulf Publication
4. Product & Process Design Principles
   Warren D. Seider, J. D. Seader, Daniel R. Lewin; Wiley Publication
5. Pinch Analysis and Process Integration
   Ian C Kamp; Butterworth-Heinemann

Course Outcome:

After Learning the course the students shall be able to:

- Relate principles heat and mass integration
- Utilize different software for heat exchanger network and water networking
- Evaluate various alternatives for heat integration of distillation columns for energy savings
- Estimate the batch cycle time required for a single/multi product plant
- Develop heat and mass exchanger networks