Shree Warana Vibhag Shikshan Mandal's

WARANA UNIVERSITY,
WARANANAGAR

(A State Public University established under Section 3 (6) of MPUA, 2016)

॥ विद्या सर्वस्य भूषणम् ॥

Warana University

Established: 2025

Structure & Syllabus

of

First Year Master of Technology (M.Tech.)

Department of Chemical Engineering

Under

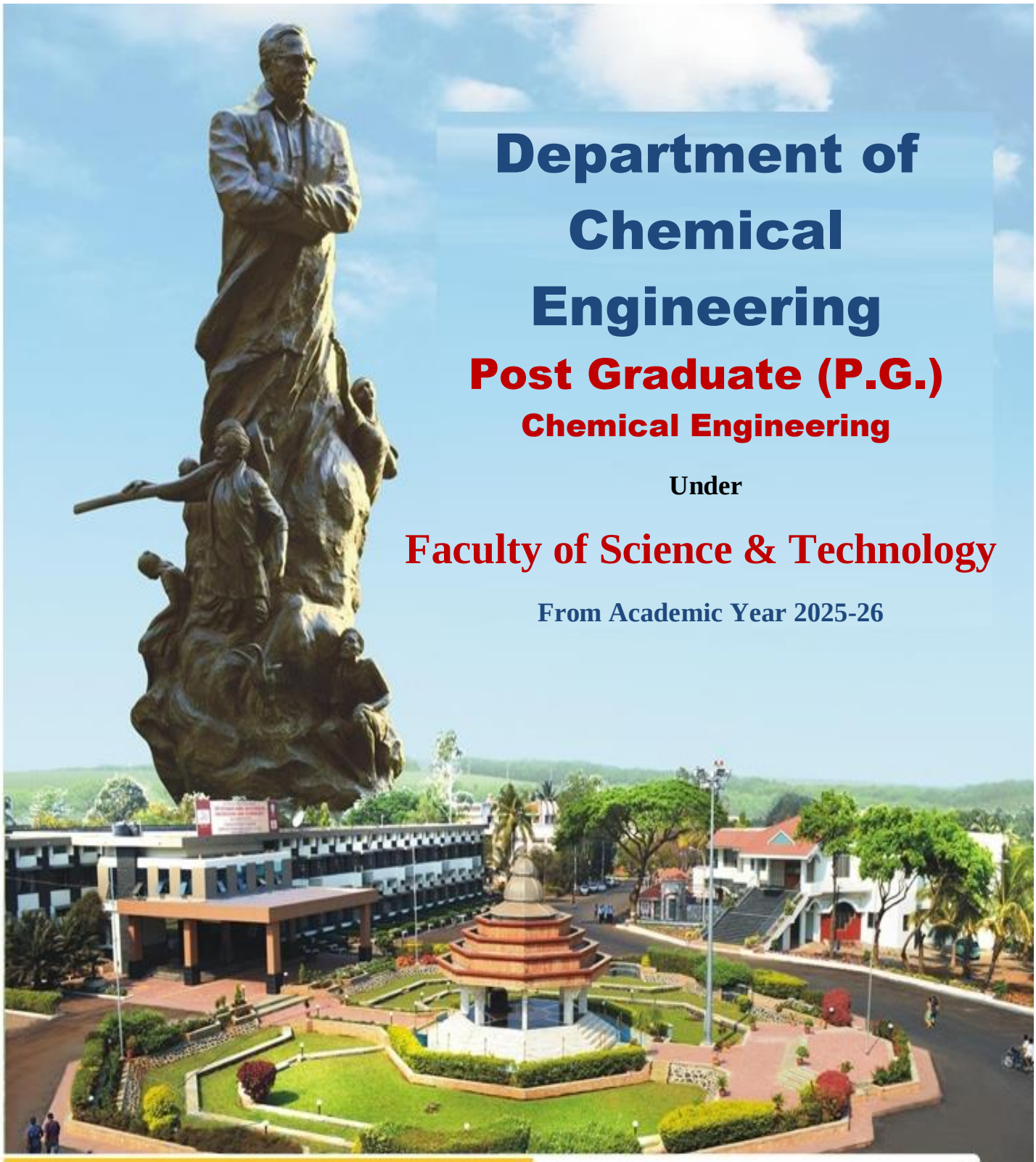
Faculty of Science & Technology

Structure and Syllabus in Accordance With

National Education Policy - 2020

With Effective from Academic Year2025-26

Shree Warana Vibhag Shikshan Mandal's
TATYASAHEB KORE INSTITUTE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS), WARANANAGAR, KOLHAPUR
Estd. 1983
Lead Institute of
WARANA UNIVERSITY, WARANANAGAR
(A State Public University)



Department of Chemical Engineering

Post Graduate (P.G.)

Chemical Engineering

Under

Faculty of Science & Technology

From Academic Year 2025-26

M. Tech. in Chemical Engineering

Structure and Syllabus under Autonomy as per NEP Policy 2020

Abbreviations

Sr. No.	Acronym	Definition
1	ISE	In-Semester Examination
2	ISE -I	In-Semester Examination I
3	ISE-II	In-Semester Examination II
4	ESE	End Semester Examination
5	TH	Theory Lecture
6	Tut	Tutorial
7	PH	Practical Hours
8	P	Practical
9	O	Oral
10	TW	Term Work
11	CH	Contact Hours
12	C	Credit

Course/ Subjects Categories

Sr. No	Acronym	Definition
1	PCC	Professional Core Course
2	PE	Program Elective
3	OE	Open Elective Course
4	LC	Laboratory Course
5	MC	Mandatory Course
6	SW	Seminar work
7	II	Industrial Internship
8	PC	Dissertation
9	SLC/AC	Self Learning Course/Audit course

First Year M. Tech. Chemical Engineering

Curriculum Structure and Evaluation Scheme

Semester-I

Sr. No.	Category	Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min. for Passing	
1	Programme Course	PCC	2501PCHE PCC101	Advanced Momentum & Heat Transfer	3	-	-	3	3	ESE	60	24	40
										ISE	40	16	
			2501PCHE PCC101T	Advanced Momentum & Heat Transfer Tutorial	-	1	-	1	1	ISA	25	10	10
			2501PCHE PCC102	Advanced Chemical Engineering Thermodynamic	3	-	-	3	3	ESE	60	24	40
										ISE	40	16	
			2501PCHE PCC102T	Advanced Chemical Engineering Thermodynamic Tutorial	-	1	-	1	1	ISA	25	10	10
2	Program Elective	PE	2501PCHE PE103X	Program Elective-I	3	-	-	3	3	ESE	60	24	40
										ISE	40	16	
			2501PCHE PE104X	Program Elective-II	3	-	-	3	3	ESE	60	24	40
										ISE	40	16	
			2501PCHE PE105X	Program Elective-III	3	-	-	3	3	ESE	60	24	40
										ISE	40	16	
3	Laboratory Course	LC	2501PCHE LC106P	Advanced Separation Laboratory	-	-	4	2	4	OE	25	10	20
										ISA	25	10	
4	Seminar Work	SW	2501PCHE SW107T	Seminar-I	-	-	2	1	2	ISA	50	20	20
					15	**2**	**6**	**20**	**23**	**--**	**650**	**260**	**260**

Note: 'X' indicates the sequence number of Program Elective (PE) offered by Chemical Engineering Program.

First Year M. Tech. Chemical Engineering

Curriculum Structure and Evaluation Scheme

Semester-II

Sr. No.	Category	Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
					L	T	P	C	CH	Component	Marks	Min. for Passing	
1	Programme Course	**PCC**	2501PCHE PCC201	Advanced Mass Transfer	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
		PCC	2501PCHE PCC201T	Advanced Mass Transfer Tutorial	--	1	--	1	1	ISA	25	10	10
		PCC	2501PCHE PCC202	Chemical Process Control	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
		PCC	2501PCHE PCC202T	Chemical Process Control Tutorial	--	1	---	1	1	ISA	25	10	10
2	Program Elective	**PE**	2501PCHE PE203X	Program Elective-IV	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
		PE	2501PCHE PE204X	Program Elective-V	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
3	Open Elective Course	**OE**	2501PCHE OE205X	Open Elective Course	3	--	--	3	3	ESE	60	24	40
										ISE	40	16	
4	Laboratory Course	**LC**	2501PCHE LC206P	Analytical Laboratory	--	--	4	2	4	ISA	25	10	10
					--	1	--	1	1	OE	25	10	10
5	Seminar Work	**SW**	2501PCHE SW207T	Seminar-II	--	--	2	1	2	ISA	50	10	10
					15	**3**	**6**	**21**	**24**	**--**	**650**	**250**	**250**

Note:

- 'X' indicates the sequence number of Program Elective (PE) offered by Chemical Engineering Program.
- Students should opt for the Open Elective (OE) course from other departments. The list of OE courses offered by other departments is available in the structure. Although the OE course code is defined by the respective program in the structure, the actual opted OE course will appear on the mark card.

First Year M. Tech. Chemical Engineering

List of Program Elective (PE)

Semester-I

	Course Code	Course Title
Program Elective-I	2501PCHEPE1031	Process Modeling in Chem. Engineering
	2501PCHEPE1032	Corrosion Engineering
	2501PCHEPE1033	Polymer & Rubber Technology
Program Elective-II	2501PCHEPE1041	Nano Technology
	2501PCHEPE1042	Green Technology
	2501PCHEPE1043	Pharmaceutical Biotechnology
Program Elective-III	2501PCHEPE1051	Bio Process Engineering
	2501PCHEPE1052	Materials Engineering
	2501PCHEPE1053	Process Equipment Design

Semester-II

	Course Code	Course Title
Program Elective-IV	2501PCHEPE2031	Modern Reaction Engineering
	2501PCHEPE2032	Catalysis & Surface Phenomena
	2501PCHEPE2033	Down Stream Processing
Program Elective-V	2501PCHEPE2041	Computational Fluid Dynamics
	2501PCHEPE2042	Energy Engineering
	2501PCHEPE2043	Advance Separation Techniques

First Year M. Tech. Mechanical (Design Engineering)

List of Open Electives (OE) Courses

Sr. No.	OE Offered by Program	Course Code	Open Elective Course
1	Chemical Engineering	2501PCHEOE2051	Project Management
2		2501PCHEOE2052	Operations Research
3		2501PCHEOE2053	Energy Technology
4	Electronics & Telecommunication Engineering	2501PETCOE2051	Advanced Operating Systems
5		2501PETCOE2052	Cyber Security
6		2501PETCOE2053	Artificial Intelligence and Machine Learning
7	Construction Management (Civil Engineering)	2501PCCMOE2051	Water Power Engineering
8		2501PCCMOE2052	Waste to Energy
9		2501PCCMOE2053	Contracts & Tenders
10	Mechanical Design (Mechanical Engineering)	2501PMDEOE2051	Cryogenics
11		2501PMDEOE2052	Design for Manufacture & Assembly
12		2501PMDEOE2053	Enterprise Resource Planning
13	Structural Engineering (Civil Engineering)	2501PCSTOE2051	Cost Management of Engineering Projects
14		2501PCSTOE2052	Optimization Techniques in Civil Engineering
15		2501PCSTOE2053	Industrial Safety
16	Computer Science and Engineering	2501PCSEOE2051	Ethical AI & Explainability
17		2501PCSEOE2052	Computer Vision
18		2501PCSEOE2053	High Performance Computing for Multidisciplinary Research

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M. Tech. Chemical Engineering Semester- I

2501PCHEPCC101: Advanced Momentum and Heat Transfer

Teaching Scheme			**Examination Scheme**	
Lectures	03Hrs/Week		ISE	40 Marks
Tutorials	01		ESE	60 Marks
Total Credits	04		TW	25 Marks
			Duration of ESE	.

Course Objectives (CO):

1: Introduce analogy between momentum and heat transfer

2: Explain general conservation equations for transport phenomena

3: Develop momentum balance for a given system at macroscopic and microscopic scale.

4: Analysis of governing equations to obtain velocity profiles

5: Assist students in developing ability to make engineering judgments, including judgements regarding process safety.

6. Discuss applications in various heat transfer equipment in process industries, Heat Transfer Augmentation & Pinch Technology

	Course Contents	**Hours**
Unit 1	. **Boundary Layer Flow:** Boundary layer equations, separation of BL, Blasius solution for flat state, properties of BL equation, Momentum integral equations.	(04)
Unit 2	**Turbulent Flow:** Reynolds equation for turbulent flow, velocity distribution for flow in pipe. Statistical theory of turbulence. Drag reduction etc. **Non-Newtonian Fluids:** Rheological behavior of non-Newtonian fluids, laminar flow in cylindrical tubes, laminar flow between parallel plates, laminar flow in annuli. Generalized relationship for power law model	(04)
Unit 3	**Agitation and Mixing:** Velocities in stirred tanks. Flow patterns in stirred tanks, Power consumptions in stirred vessels, mixing equipment's. **Multiphase Flow:** Two phase gas vapor liquid flow, horizontal and vertical flow of gas-liquids, liquids, gas-solid mixtures, slip and hold up effect, phase separation and settling behavior, analysis of stratified and bubble flow, formation of bubbles and drops and their size distribution and hold up in different flow system, momentum and energyrelations. **Motion in The Fluidized Bed:** Bubbling fluidization, semi-fluidization, mixing and segregation in fluidized bed, Numerical and application of fluidization.	(06) (05)

Unit 4	**Introduction: Review of heat Transfer, t**ransient heat conduction; Lumped system analysis, heat transfer analogies. **Turbulent Forced Convective Heat Transfer:** Momentum and energy equations - turbulent boundary layer heat transfer – mixing length concept - turbulence model, Heat pipe.	(04)
Unit 5	**Heat Transfer In Two Phase Systems:** Heat transfer regimes and flow maps. Condensation: Basic process, on planner surface, inside and over pipe of pure and multicomponent vapors. Heat transfer in paced bed and fluidized beds. Overall pressure drop and void calculation methods. Flow regimes in two phase flow. Drift flux model, annular flow, critical flow, flow instabilities, homogeneous flow, and separated flow. **Non-Newtonian Flow Heat Transfer:** Comparative study of Newtonian and non-Newtonian fluid in context with heat transfer, Newtonian and non-Newtonian heat transfer in circular tube, coils and other configuration, Non-Newtonian heat transfer in PFR, CSTR. Generalized relationship of power law fluid, forced convection heat transfer to Bingham plastic and power law fluid in circular conduits.	(05) (04)
Unit 6	**Heat Transfer Augmentation:** Active and passive techniques, rough surface, swirl flow generation and compound augmentation. Compact heat exchangers. Introduction of Pinch Analysis and Process integration.	(05)

Assignments: Each student will submit minimum 6 assignments based on the different topics in consultation with faculty, in the area of advanced momentum and heat transfer ; keeping track of the recent technological trends and developments.

Course Outcomes (CO): At the end of course students will

1: Able to understand the chemical and physical transport processes and their mechanism

2: Able to do heat, mass and momentum transfer analysis

3: Able to analyze industrial problems along with appropriate approximations and boundary conditions

4: Able to develop steady and time dependent solutions along with their limitations

5: Understand the concepts of boundary layer and its estimation in different flows

6: Understanding of various types of heat transfer process and devices

Text Books

1	R.B. Bird, W.E. Stewart and E.N. Lightfoot, ―Transport Phenomena , John ‖ Wiley & Sons, Inc, New York
2	Ranjeet Basugade ,- Advance Heat Transfer Augmentation Technique: Heat Transfer Augmentation in Triangular Fin Heat Exchanger Using Rectangular Wings Kindle
3	Pinch Analysis and Process Integration A User Guide on Process Integration for the Efficient Use of Energy Second edition by Ian C Kemp
2	The Flow of Complex Mixture in Pipes" by Govier and Aziz
3	Chemical Engineering" by Coulson and Richardson, Volume I
4	D.G. Knudsan and D. L. Katz. Fluid Dynamics and Heat transfer. Mc-Graw Hill,
5	C.J. Geankoplis" Transport Processes Momentum And Mass" Bacon Inc.
6	HArison & Davidson, Fluidization Engg, Mc-Graw Hill, 1968

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M. Tech Chemical Engineering Semester- I

2501PCHEPCC102: Advanced Chemical Engineering Thermodynamics

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	01 Hr/Week		ESE	60 Marks
Total Credits	04		TW	25 Marks
			Duration of ESE	.

Course Objectives (CO):

1. Define & describe the basic laws of thermodynamic
2. Explain the criteria for equilibrium with stability of thermodynamic system.
3. Develop skills to make appropriate assumptions and ability to predict intermolecular potential and excess property behavior of multi- component systems.
4. Analysis & estimation of the Gibbs free energy and fugacity of a component in mixture
5. Judge the Chemical equilibrium and evaluate the degrees of freedom for chemically reacting systems
6. Discuss statistical thermodynamic terms.

	Course Contents	**Hours**
Unit 1	**Detailed review of thermodynamics laws and basic concepts:** Laws of thermodynamics, Concepts of entropy, Intensive and extensive variables, Enthalpy, Gibbs free energy, Equations of state, other important thermodynamic properties.	(08)
Unit 2	**Equilibrium and Stability in one component systems:** The criteria for equilibrium, Stability of thermodynamic system, The molar Gibbs free energy and fugacity of a pure component. The Gibbs phase rule for one component system. Thermodynamic properties of phase transitions Problems.	(08)
Unit 3	**The Thermodynamic of Multi Component Mixtures:** The thermodynamic description of mixtures. The partial molar gibbs free energy and the generalized Gibbs – Duhem equation. A notation for chemical reactions. The equations on change for a multicomponent system. Thermodynamic state for a multicomponent multi phase system. The Gibbs phase rule Problems (Non Reactive).	(08)

Unit 4	**The estimation of the Gibbs free energy and fugacity of a component in mixture:** The ideal gas mixture, The partial molar mixture properties. The fugacity of a species in gaseous, liquid and solid mixtures. Several correlative liquid mixtures (activity coefficient) models Problems. UNIFAC method, UNIQUAC equation, Vapor liquid equilibrium using activity coefficient models, problems.	(08)
Unit 5	**Chemical Reaction equilibrium:** Chemical equilibrium in a single-phase system, Heterogeneous chemical reactions, Chemical equilibrium when several reactions occur in single phase, Phase rule and Duhem's theorem for reacting systems, Degree of freedom analysis for non-reacting and reacting systems	(08)
Unit 6	**Introduction to Statistical thermodynamics:** Quantum considerations, Microstates, Macrostates and thermodynamic probability, Physical models, Boltzmann statistics, Fermi–Dirac statistics and Bose – Einstein statistics, Partition function, Phase space,	(08)

Assignments: Each student will submit minimum 6 assignments based on the different topics in consultation with faculty, in the area of thermodynamics of phase equilibria & chemical equilibria keeping track of the recent technological trends
and developments.

Course Outcomes (CO): At the end of course, students should be able to

1.Formulate and manipulate the thermodynamic treatment of arbitrary processes.

2.Formulate and analyze specific Chemical Engineering problems using fundamental concepts.

3.Select appropriate approximations for practical problem solving.

4.Understand the implications of approximations on the efficiency and accuracy of the solution

Text Books

1	Chemical Engineering Thermodynamics – Stanlay Sandler IInd edition Wiley graham in chemical engineering.

Reference Books	
1	Introduction to Chemical Engineering Thermodynamics: J.M. Smith, H.C.Vanness McGraw Hill International book company.
2	Thermodynamics – by J.P.Holman IVth edition McGraw Hill Inter
3	Statistical thermodynamics- M.C.Gupta Wiley Eastern Ltd.
4	” Chemical Engineering Thermodynamics” K.V.Narayanan
5	“Principles of Chemical Equilibrium”, Kenneth Denbigh
6	“Chemical Engineering thermodynamics”, Y. V. C. Rao,
7	” Chemical Engineering Thermodynamics“, T. E. Daubert
8	“Chemical and Process Thermodynamics”, B. G. Kyle
Useful Websites	
1	http://nptel.ac.in/
2	http://swayam.gov.in/
3	http://www.youtube.com/user/nptelhrd

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- I

2501PCHEPE1031: Process Modeling in Chemical Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Objectives (CO):

1. Introduce fundamentals of creating mathematical models of chemical process systems.
2. Generate steady and dynamic model for different processes.
3. Solve process design problems, based on fundamental analysis and using mathematical models of chemical processes.
4. Implementation on mathematical tools to analyze the system both to gain insight and make predictions.
5. Explain verification/ validation of simulation model through the simulators.

	Course Contents	**Hours**
Unit 1	**Introduction to dynamic models:** Mass balance equation - Balancing procedure, Case studies: CSTR, Tubular reactor, Coffee percolator, Total mass balance – Case Studies: Tank drainage, Component balances - Case Studies: Waste holding tank, Energy balance- Parallel reaction in a semi continuous reactor with large temperature difference, Momentum balances – CSTR, Gas liquid mass transfer in a continuous reactor**.** **Modeling of stage wise processes:** Reactor Configurations, Generalized model description, Heat transfer to and from reactors, Steam heating in jacket, Dynamics of the metal jacket walls.	(06)
Unit 2	**Mass transfer models:** liquid-liquid extraction, distillation, Multicomponent separation, multi component steam distillation, absorber- stage wise absorption, steady state gas absorption with heat effects, evaporator**.** **Model Discrimination And Parameter Estimation:** Rate equations, Batch reactor – Constant volume, Semi - batch reactor, CSTR - Constant volume CSTR, CSTR cascade.	(06)
Unit 3	**Lumped and distributed system:** Distributed system- Counter current heat exchanger, Flasher design, Condensation, Definition of lumped parameter model**.** Mathematical models of heat- transfer equipments: Shell & tube heat exchangers, Evaporators, Fired heaters, Partial condensers. Plug flow reactor, Plug flow reactor contactors, Liquid –liquid extraction column dynamics.	(06)
Unit 4	**Flow sheet simulation :** Process flow sheet simulation, Process and information matrix, Materials and Energy balance computation using modular approach, Process analysis, Process variables, selection, Equipment selection.	(06)
Unit 5	**Dynamic simulation:** Dynamic simulation of Reactors, distillation column, Absorbers, evaporators and crystallizes, introduction to simulation packages like GPSS, CSMP.	(06)

Unit 6	**Process Simulators:** Introduction to professional simulator like UNISIM, Aspen. Mathematical tools like SciLab, Introduction to Solver and Poly Math etc.	(06)

Course Outcomes (CO): At the end of course students will

1. Define physical problems in terms of mathematical modeling and how it is related.
2. Apply the need for modeling, estimate necessary model complexity through modeling process.
3. Recognize how models are developing from rate laws, balances and constitutive equations.
4. Solve the basis of chemical engineering process and adjustable parameters in them.
5. Analyze the mathematical tool to predict the chemical engineering process
6. Create the small modeling with simulation for any physical chemical engineering problem

Text Books

1	John Ingham, Irving, J. Dunn, Elmar, Heinzle Jiri, E. Prenosil, "Chemical Engineering Dynamics", VCH Publishers Inc., New York, 1974.
2	Lubeyn W.L. "Process Modeling, Simulation and Control Engineering ", McGraw Hill Book
3	Edgar, T.F. and D.M. Himmelblau - "Optimization of Chemical Processes ", McGraw Hill BookCo., New York, 1989.
4	R. W. Gaikwad, Dr. Dhirendra, "Process Modeling and Simulation", Central Techno Publications, Nagpur, 2003.

Reference Books

1	C. L. Smith, R. L. Pike and P. W. Murill, "Formulation Optimization of Mathematical models", International Text, Pennsylvania, 1970.
2	Roger G. E. Franks, "Modeling and Simulation in Chemical Engineer", Wiley Inter Science, New York, 1972.

Useful Websites

1	Moocs/ Swayam Courses on Process Modeling & Simulation in Chemical Engineering, OpenModelica

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- I

2501PCHEPE1032: CORROSION ENGINEERING

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Objectives (CO):

1. Introduce fundamentals of Corrosions.
2. Corrosion measurement techniques.
3. Mechanisms of corrosion.
4. Environmental aspects of corrosion.
5. Explain prevention and control of corrosion.

	Course Contents	**Hours**
Unit 1	**Basic concepts**: Definition and importance, Electrochemical nature and forms of corrosion, Corrosion rate and its determination.	(06)
Unit 2	**Electrochemical thermodynamics and kinetics**: Electrode potentials, Potential-pH (Pourbiax) diagrams, Reference electrodes and experimental measurements, Faraday's laws, Instrumentation and experimental procedure.	(06)
Unit 3	**Corrosion measurement through polarization techniques**: Tafel extrapolation plots, Polarization resistance method, Commercial corrosion probes, Other methods of determining polarization curves.	(06)
Unit 4	**Pitting and crevice corrosion**: Mechanisms of pitting and crevice corrosion, Secondary forms of crevice corrosion, Localized pitting, Metallurgical features and corrosion: Intergranular corrosion, Weldment corrosion, De-alloying and dezincification. .	(06)
Unit 5	**Environmental induced cracking**: Stress corrosion cracking, Corrosion fatigue cracking, Hydrogen induced cracking, Methods of prevention and testing, Erosion, Fretting and Wear.	(06)
Unit 6	**Environmental factors and corrosion**: Corrosion in water and aqueous solutions, Corrosion in sulphur bearing solutions, Microbiologically induced corrosion, Corrosion in acidic and alkaline process streams. **Prevention and control of corrosion**: Cathodic protection, Coatings and inhibitors, Material selection and design.	(06)

Course Outcomes (CO): At the end of course students will	
1. Define fundamentals of Corrosions.	
2. Apply the Corrosion measurement techniques..	
3. Recognize Mechanisms of corrosion.	
4. Solve the problems related to the environmental impact of corrosion.	
5. Analyze the problem and its preventive actions.	
Text Books	
1	Fontana, M.G., Corrosion Engineering, Tata McGraw-Hill (2008). 3rd ed. (seventh reprint)
2	Jones, D.A., Principles and Prevention of Corrosion, Prentice-Hall (1996).
Reference Books	
1	Pierre R. Roberge, Corrosion engineering: principles and practice, McGraw-Hill (2008).
2	Sastri, V.S., Ghali, E. and Elboujdaini, M., Corrosion prevention and protection: Practical solutions, John Wiley and Sons (2007)..

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M. Tech Chemical Engineering Semester- I

2501PCHEPE1033 Polymer and Rubber Technology

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Objectives (CO):

1 Define & describe the basics of polymer and rubber.

2 Explain the criteria for the polymerization process.

3 Develop skills to understand and study various processes of polymer and rubber production.

4 To understand the advances in polymer and rubber technologies.

5 To prepare the students to take challenges of polymer field in his profession.

	Course Contents	**Hours**
Unit 1	**Polymerization Fundamentals** – Introduction and importance of polymers, Development of polymers, Classification of polymers based on physiochemical structure, Types of polymerization, Mechanism of polymerization, Physical properties and technical application, Polymer structure and stereo-regular polymers Molding of plastics into articles, Homogeneous, Bulk, Solution, Emulsion and suspension polymerization and their Comparison	(06)
Unit 2	**Manufacture of industrially important polymers for Plastics** – Raw materials, polyolefines- polythene, Poly propylene, Vinyl polymers-polyvinyl chloride, polyvinyl acetate, polyvinyl alcohol, polyvinylidiene chloride, Formaldehyde and Epoxy resins and their types, alkyd resins, polyacrylonitrile, polystyrene and copolymers of styrene, polysters and polyamides,	(06)
Unit 3	**Manufacture of industrially important polymers for Synthetic fibers** –Introduction , Classification , properties and preparation , Nylon -6 , Nylon – 66, Rayon, Sillicones, Poly silicones, Orlan, Saron, Teflon, Cellulose, and its derivatives.	(06)

Unit 4	**Manufacture of rubber and elastomers** – Introduction and importance of rubber, physical and chemical properties of rubber, Classification, Natural Rubber- Structure and properties, Rubber latex production and processing, synthetic rubber- Polymerization methods and unit operations involved, Styrene – Butadiene copolymers, Nitrile rubber, Neoprene, Butyl Rubber, Polyisoprene, Polybutadiene, Thiokol, Hypalon, Sillicone Rubber, Polyurethane rubber, Spandex, Sponge rubber, Foam rubber, Laminates, Rubber cement.	(06)
Unit 5	**Processing and manufacture of rubber products –** Vulcanizing, Compounding, Rubber chemicals, Processing equipment and method, Tyres and tubes manufacture, Reclamation of rubber, Applications of rubber.	(06)
Unit 6	**Polymer and rubber industries in India** – Development and scope of plastics, Synthetic Fibre, and elastomer industry in India.	(06)

Course Outcomes (CO): At the end of course students should be able to
1 Understand polymer and rubber processing
2 Formulate and analyze specific polymer & rubber Engineering problems using fundamental concepts.
3 Select appropriate approximations for practical problem solving.
4 Understand the future of polymer & rubber industry in Indian context.
5 Understand advanced processes

Text Books

1	. G.S. Misra, ―Introductory Polymer Chemistry‖ , Wiley Eastern Ltd.,New Delhi,1993.
2	D.C. Miles, ―Polymer Technology‖ , Chemical Publishing New York, 1979.
3	Fred Billmeyer, ―A Text Book of Polymer Science‖ , 3rd Edition, John Wiley and Sons, New York, 1984.
4	b.k.Sharma ,"Industrial Chemistry," 10th edition, Krishna Prakashan,India Pvt. Ltd. Meerut, 1999

Reference Books

1	Anil Kumar, S.K. Gupta, ―Fundamentals of Polymer Science and Engineering‖ , Wiley, 1978.
2	D.J. Williams, ―Polymer Science and Engg‖ . Prentice Hall, New York 1971.
3	F. Rodrigues, ―Principles of Polymers systems‖ , McGraw Hill, New York 1970
4	George Odian, ―Principles of Polymerization‖ , 2nd Edition John Wiley and Sons, New York 1981.

Useful Websites	
1	http://nptel.ac.in/
2	http://swayam.gov.in/
3	http://www.youtube.com/user/nptelhrd

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- I

2501PCHEPE1041 Nanotechnology

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	---
			Duration of ESE	.

Course Objectives (CO):

1. Introduce fundamentals of Nanoscience and Nanotechnology.
2. Study the concept of nanomaterials.
3. Explain the synthesis, purification and application of nanomaterials.
4. Study the advances in nanotechnology
5. Intellectual property rights of nanotechnology

	Course Contents	**Hours**
Unit 1	**Introduction to Nanotechnology:** History, Importance of Nanoscales, Fundamental concepts (Bottom-up and Top-down processes).	(07)
Unit 2	Application of Nanotechnology	(07)
Unit 3	**Nanomaterials:** Fundamental concept of nanomaterial, Materials used in nanotechnology, carbon nanotubes-properties	(07)
Unit 4	Synthesis, Purification, Application of Nanomaterials.	(06)
Unit 5	Recent Advances in Nanotechnology	(07)
Unit 6	**Intellectual property rights on Nanotechnology:** Importance of IP Protection, copy rights and trade secrets	(06)

Course Outcomes (CO): At the end of course, students will

1. To understand the application of Nanoscience in catalysis and green chemistry.
2. Demonstrate the understanding of length scale concepts, nanostructures and nanotechnology.
3. Characterization of nanomaterials.
4. Physico chemical aspects of different types of nanostructures.
5. Systematically solve scientific problems related specifically to nano-technological materials using conventional scientific and mathematical notation
6. Identify the principles of processing, and synthesis of nanomaterials and nanostructures

Text Books / Reference Books

1	Principles of Nanotechnology" , Phani umar
2	"Nanomaterials",Vishwanathan
3	"The Nanoscope" Encyclopedia of Nanoscience and Nanotechnology Vol I to Vol 6, Edited by Dr.Parag Diwan and Ashish Bharadwaj

TatyasahebKore Institute of Engineering & Technology, Warananagar

First Year M.Tech Chemical Semester- I

2501PCHEPE1042 Green Technology

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	---		ESE	60 Marks
Total Credits	03		TW	-----
			Duration of ESE	.

rse Objectives (CO):

1.To present different concepts of green technologies.

2. To acquire principles of Energy efficient technologies

3. To gain knowledge of the importance of life cycle assessment

4. To learn the importance of green fuels and its impact on environment.

5 To learn zero pollution control aspect

	Course Contents	**Hours**
Unit 1	Introduction to Organic Chemistry /Analytical Chemistry /Basic Chemical Engineering	(04)
Unit 2	Introduction to Green Chemistry**:** Principles of Green Chemistry, Reasons for Green Chemistry (resource minimisation, waste minimisation, concepts), Green reactions solvent free reactions, Catalyzed (heterogeneous/homogeneous) reactions, MW/ Ultrasound mediated reactions, Bio catalysts etc	(08)
Unit 3	Introduction to Pharmaceutical Process Chemistry: Introduction to process chemistry, the difference between synthesis and process,	(07)
Unit 4	Rote design, Route optimization, DOE	(05)
Unit 5	Role of Analytical Chemistry in Process Chemistry Role of Process Safety in Process Chemistry: TH classification, MSDS, Thermal Hazards, Waste segregation and disposal.	(07)
Unit 6	Scale-up aspects including PE in Process Chemistry: Case Studies; New Initiatives: Micro reactors.	(06)

Course Outcomes (CO): At the end of course students will

1. Understand the principles of green chemistry and engineering
2. Design processes those are benign and environmentally viable

3. Design processes and products those are safe and hazard free	
4. Learn to modify processes and products to make them green safe and economically acceptable.	
5. Apply the principles of green technology to specific industrial processes	
Reference Books	
1	James H.Clarke & Duncan Maacquarrie, Handbook of Green Chemistry and Technology, Wiley-Blackwell; 1 edition (2002)
2	Paul T.Anastas and John C. Warner, Green Chemistry: Theory and Practice, Oxford University Press, USA (2000)
3	M.Lancaster, Green Chemistry (Paperback), Royal Society of Chemistry; 1 edition (2002)
4	Stanley E.Manahan, Green Chemistry and the Ten Commandments of Sustainability, 2nd ed (Paperback), ChemChar Research Inc (2005)
5	Albert Matlack, Introduction to Green Chemistry (Hardcover), CRC Press; 1 edition (2001)
6	Green Chemistry in the Pharmaceutical Industry, Peter Dunn (Editor), Andrew Wells (Editor), Michael T. Williams (Editor), Wiley-VCH (2010)

Tayasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Chemical Semester- I

2501PCHEPE1043 Pharmaceutical Biotechnology

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	---		ESE	60 Marks
Total Credits	03		TW	-----
			Duration of ESE	.

Course Objectives (CO):

1. To understand and evaluate the different pharmaceutical parameters of the current and future biotechnology related products on the market
2. Biotechnology products and their use in therapeutics and diagnostics will be discussed. The advantages of these products over conventional drugs will also be discussed
3. To Develop skills in biotechnological techniques for obtaining and improving the quality of natural products.
4. Imparts knowledge of enzymes, biosensors, Diagnostic kit.
5. Imparts knowledge of Bioprocess engineering and technology

	Course Contents	**Hours**
Unit 1	Drug Development in Pharmaceutical Process- Production of pharmaceuticals by genetically engineered cells (hormones, interferrons) - Microbial transformation for production of important pharmaceuticals (steroids and semi-synthetic antibiotics)	(07)
Unit 2	Techniques for development of new generation antibioticsl, Protein engineering, drug design, drug targeting.	(06)
Unit 3	Disease Diagnosis and Therapy, ELISA and hybridoma technology,DNA vaccine, Gene Therapy, Toxicogenomics.	(06)
Unit 4	Proteomics in Drug Development, Role of Proteomics in Drug Developmen.	(05)
Unit 5	Diagnosis of disease by Proteomics, Separation and identification techniques for protein analysis, Development of antibody-based protein assay for diagnosis.	(06)
Unit 6	Diagnosis and Kit Development, Use of enzymes in clinical diagnosis, Use of biosensors for rapid clinical analysis, Diagnostic kit development for microanalysis.	(06)

Course Outcomes (CO): At the end of course, students will

Reference Books	
1	Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (ed), Concepts in Biotechnology, University Press, 1996
2	Epenetos A.A. (ed), Monoclonal antibodies: applications in clinical oncology, Chapman and Hall Medical, London

1. Understand the various techniques used in modern biotechnology.
2. Design research strategy with step-by-step instructions to address a research problem
3. Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic
4. Demonstrate and Provide examples on how to use microbes and mammalian cells for the production of pharmaceutical products.
5. Explain the general principles of generating transgenic plants, animals and microbes

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Chemical Engineering Semester- I

2501PCHEPE1051Bio Process Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials			ESE	60 Marks
Total Credits	03		TW	
			Duration of ESE	.

Course Objectives (CO):

1. Apply engineering principles to address issues in bioprocesses
2. Analyze and identify limiting factors in a bioprocess and Propose solutions to address biological and engineering problems
3. Explain the aerobic and anaerobic fermentation processes
4. Describe applications and solve problems relating to the use of enzymes for industrial Bioprocessing
5. Determine and analyze Mass transfer in heterogeneous biochemical reaction systems with process parameter
6. Improve chemical parameters in bioreactors

	Course Contents	**Hours**
Unit 1	Review of fundamentals of microbiology and biochemistry. Bioprocess principles: Kinetics of biomass production. Substrate utilization and product formation.	(06)
Unit 2	Batch and continuous cultures. Fed batch culture introduction. Fermentation processes. General requirements of fermentation processes.	(06)
Unit 3	An overview of aerobic and anaerobic fermentation processes. Examples of simple and complex media. Design and usage of commercial media for industrial fermentation. Thermal death kinetics of microorganisms. Heat sterilizations of liquid media. Filter stabilizations of liquid media and air.	(06)

Unit 4	Enzyme technology- Microbial metabolism enzymes classification and properties. Applied enzyme catalysis-kinetics of enzyme catalytic reaction. Metabolic pathways. Protein synthesis in cells. Bioreactor design and operations. Selection scale up operations of bioreactors.	(06)
Unit 5	Mass transfer in heterogeneous biochemical reaction systems. Oxygen transfer rates and coefficients. Role of aeration and agitation in oxygen transfer. Heat transfer processes in biological systems. Recovery and purification of products.	(06)
Unit 6	Introduction to instrumentation and process control in bioprocesses. Measurement of physical and chemical parameters in bioreactors. Monitoring and control of dissolved oxygen, pH, Impeller speed and temperature in a stirred fermenter	(06)

Course Outcomes (CO): At the end of course, students should be able to

1. Understanding of biological basics and bioprocessing
2. Understanding the difference between bioprocesses and chemical processes
3. Bioprocess design and operation
4. Choice of bioreactor
5. Heat & mass transfer considerations and scale up of bioprocesses
6. Introduction to bioprocess monitoring/control

Text Books

1	M. L. Shuler, F. Kargi. Bioprocess engineering. 2nd edition. PHI. New Delhi. 2002.
1	J. E. Bailey, D. F. Ollis. Biochemical engineering. 2nd edition. Mc Graw Hill Publication co.NY.1985..
2	Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, 2001

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M. Tech Chemical Engineering Semester- I

2501PCHEPE1052 Material Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials			ESE	60 Marks
Total Credits	03		TW	
			Duration of ESE	.

Course Objectives (CO):

1. Explain the engineering materials characterization
2. Explain Metallic phases and their properties
3. To understand the principles of optical and electron microscopy for study of macro and micro-structure of materials.
4. Inspect properties through change in various parameters over composite materials
5. To gain knowledge in understanding the tools and techniques for studying the substructure and atomic structure of materials
6. To build an expertise in characterization of engineering materials.

	Course Contents	**Hours**
Unit 1	Engineering requirement of materials, atomic bonding, atomic arrangements, structural imperfections and atom movements, electronic structures & process binary alloys and equilibrium diagrams.	(06)
Unit 2	Metallic phases and their properties, phase transformations in iron carbon system.	(06)
Unit 3	Heat treatment, surface hardening, case hardening metals and their alloys, organic materials & their properties, ceramic phases and their properties, multiphase materials, reactions within solid materials.	(06)
Unit 4	Modification of properties through change in microstructure, corrosion, oxidation, thermal stability, radiation damage, composite materials	(08)
Unit 5	Crystallography, X-Ray Diffraction Methods, Reitveld Refinement, Neutron Diffraction, X-ray absorption, XRay Fluorescence spectroscopy, Electron Diffraction- diffraction pattern in specific modes.	(06)

Unit 6	LEED and RHEED, Electron Optics, Electron Microscopy-Transmission and Scanning Electron Microscopy, STM and AFM, Compositional analysis employing AES, ESCA and Electron Probe Microanalysis.	(06)

Course Outcomes (CO): At the end of course students should be able to

1. To review physics and chemistry in the context of materials science & engineering
2. To describe the different types of bonding in solids, and the physical ramifications of these differences
3. To describe and demonstrate diffraction, including interpretation of basic x-ray data.
4. To promote an understanding of the relationship between material structure, processing and properties
5. Gain important conceptual and operational understanding of a wide range of methods for characterizing Materials
6. Gained a broad perspective on materials chemistry and physics

Reference Books

1	James F. Shackelford, Introduction to Materials Science for Engineers, 7th Edition, Pearson Prentice Hall(2009)
2	W. D. Callister, Fundamentls of Materials Science and Engineering, Wiley (2007)
3	C. Kittle, Introductin to Solid State Physics, Wiley (2007)
4	R. W. Cahn and P. Haasen, Physical Metallurgy, North Holland (1996)
5	Bradley D. Fahlman Materials Chemistry, Kindle Edition 2008).
6	B.D.CullityElementS of X-ray Diffraction AddisionWesely Reading Mass 1978.
7	David D. Brandon and Wayne D. Kaplan Microstructural Characterization of Materials wiley
8	Dawn Bonnel Scanning Probe Microscopy and Spectroscopy: Theory, Techniques, and Applications 2000.
9	C. Julian Chen Introduction to Scanning Tunneling Microscopy Monographs on the Physics and Chemistry of Materials

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M. Tech Chemical Engineering Semester- I

2501PCHEPE1053 Process and Equipment Design

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Objectives (CO):

1 Define and describe the basic design procedure for an equipment.

2 Explain the use of formula and correlations used for designing of equipment.

3 Develop skills to make appropriate assumptions and ability to predict the data required for designing.

4 Analysis and estimation of predicted data with calculated values.

5 Judge the design parameters along with the permissible design guidelines.

6 Discuss about trial-and-error estimations.

	Course Contents	**Hours**
Unit 1	**Shell and Tube Heat exchanger**: Classification, Shell and Tube side Heat Transfer Coefficients, Pressure drop, Fouling, Baffles, Passes Tubes Tube Sheet, Effectiveness, of Heat exchanger, Heat Exchangers sizing For Heating or Cooling in agitated vessel.	(06)
Unit 2	**Heat Exchange equipment**: Plate Heat Exchanger, Bayonet Heat Exchanger, Heat Regenerator, Thermic Fluid Heating System Design Consideration.	(06)
Unit 3	**Heat Exchange equipment**: Cooling Tower Design Consideration, Cooling Water Blow Down, Cooling Water Corrosion, crossed flow induced Draft Cooling Tower, Evaporation, Single and Multiple Effect forward and Backward Feed Evaporators.	(06)
Unit 4	**Reactor**: Reactor Classification, Design Equation for Batch PFR and CSTR, Fluidized Bed Reactor, Scale Up.	(06)
Unit 5	**Separation Equipment**: Classifications of Separator, Design Procedure For Gas Liquid Separator Oil Water Separator, Decanter, Gravity Separators, Centrifugal Separators **Gas Cleaning Equipment**: Cyclone Separator, Electrostatic Precipitator, Granular Bed Filter, Hydro-cyclone.	(06)

Unit 6	**Pipe lines**: Pipe Thickness, Pipe diameter, Condensate Piping, Pipe Support, Design of Pipeline for Natural Gas, Transportation of Crude oil, Pipe Line in Sea Water, Pipeline Design on Fluid Dynamics Parameters.	(06)

Course Outcomes (CO): At the end of course, students should be able to	
1 Recall their concepts in designing the chemical equipment's	
2 Interpret causes of failure of chemical equipment	
3 Have awareness on advances in process engineering design of many process equipment's	
4.Take part in remedial or preventive measurements to avoid failure of vessel with safe design Guide lines	
5 Evaluate and apply their ideas on dimensional analysis to explore the optimum design variables	
6 Test the process equipment with prior safety.	
Text Books	
1	Process Design of Equipment's Vol.-1, 4th Edition by Dr. S.D. Dawande, Denett & Company Publication 2011
2	Process Design of Equipment's Vol.-2, 4th Edition by Dr. S. D. Dawande, Denett & Company Publication 2012
Reference Book	
1	Introduction to Process Engineering and Design 4th Reprint 2011, S. B. Thakore, B. I. Bhatt, Tata Mc-. Graw Hill, Education Pvt. Ltd, Delhi
Useful Websites	
1	http://nptel.ac.in/
2	http://swayam.gov.in/
3	http://www.youtube.com/user/nptelhrd

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Chemical Engineering Semester- I

2501PCHELC106 ADVANCED SEPARATION LABORATORY

Teaching Scheme			**Examination Scheme**	
Lectures	----		ISE	
Tutorials	---		ESE (Oral)	25
Practical	02Hrs/Week		TW	25
Total Credits	02		Duration of ESE	------.

Course Objectives (CO):

1.Learn new techniques of separation

2.Learn possible cases of industrial application.

3. Learn estimation of separation coefficient.

	Course Contents	**Hours**
1	Ultra filtration a) Pilot scale	(04)
2	Ultra filtration a) Small scale	(04)
2	Supported liquid membranes.	(04)
3	Microfiltration of raw material	(04)
4	Ion Exchange a) Resin	(04)
5	Ion Exchange b) Equilibria	(04)
6	Ion Exchange c) Column	(04)
7	*Electro coagulation*	(04)
8	*Pressure swing Adsorption*	(04)
9	Electrostatic precipitator	(04)

Course Outcomes (CO): At the end of course, students will get

1.Knowledgeof recent advances in separation techniques.

2. Ability to separate different chemical compounds.

3. Ability to handle different advance equipment's.

4.Considerably more in-depth knowledge of the major subject.

5.Deeper knowledge of Experimental methods

6. Knowledge of industrial methods used for the separation processes.

Reference Books

1	C.J.King "Separation Processes" 2nd Ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1986.
2	Sirkar K. & Winston H.O. "Membrane Hand Book" Van Nostrand Reinhold, New York, 1992.
3	McCabe & Smith "Unit Operations of Chemical Engineering" 5th Ed.,McGraw Hill International.
4	Richardson and Coulson,"Chemical Engineering Volume –II",Pergamon Press,1970.
5	Schweitzer P.A , "Handbook of Separation Techniques for Chemical Engineering" 2nd edn., McGraw Hill

	Book Co.,1986.
6	Souri Rajan S. "Reverse Osmosis" Logos Press Ltd.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year MTech. Chemical Engineering Semester- I

2501PCHESW107 Seminar – I

Teaching Scheme			**Examination Scheme**	
Lectures	-----		ISE	---
Tutorials	---		ESE (Oral)	---
Practical	02Hrs/Week		TW	50
Total Credits	01		Duration of ESE	------.

Course Objectives (CO):

1.To Identify, understand and discuss current, real-world issues.

2.To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g., humanities and sciences) with that of the student's own academic discipline (e.g., in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.). And apply a multidisciplinary strategy to address current, real-world issues.

3. To Improve oral and written communication skills.

4. To Improve presentation skills

	Course Contents	**Hours**
1	Seminar-I should be based on the literature survey on any topic relevant to Design Engineering (should be helpful for selecting a probable title of the dissertation). Each student has to prepare a write up of about 25-30 pages of "A4" size sheets and submit it in IEEE format in duplicate as the term work. The student has to deliver a seminar talk in front of the faculty of the department and his classmates. The concerned faculty should assess the students based on the quality of work carried out, preparation and understanding of the candidates. Some marks should be reserved for the attendance of a student in the seminars of other students.	(--)

Course Outcomes (CO): At the end of course, students will

1. Apply principles of ethical leadership, collaborative engagement, socially responsible behavior, respect for diversity in an interdependent world, and a service-oriented commitment to advance and sustain local and global communities.

2. Learn and integrate. Through independent learning and collaborative study, attain, use, and develop knowledge in the arts, humanities, sciences, and social sciences, with disciplinary specialization and the ability to integrate information across disciplines.

3. Think and create. Use multiple thinking strategies to examine real-world issues, explore creative avenues of expression, solve problems, and make consequential decisions

4.Communicate. Acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication that demonstrates respect and understanding in a complex society.

SEMESTER-II

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar				
First Year M.Tech. Chemical Engineering Semester- II				
2501PCHEPCC201 Advanced Mass Transfer				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	01 hr/Week		ESE	60 Marks
Total Credits	04		TW	25 Marks
			Duration of ESE	.

Course Objectives (CO):

1	Introduce fundamentals of macroscopic and microscopic models of chemical process systems.
2	Compare and classify various mass transfer operations with or without chemical reaction.
3	Solve process design problems, based on fundamental analysis and using mathematical models of chemical processes.
4	Implementation on mathematical predictions for multi-component system.
5	Explain Extraction, ion-exchange, adsorption processes.

	Course Contents	Hours
Unit 1	**Physical-Chemical Phenomena:** Diffusivity and mechanism, Diffusion dispersion, Diffusivity measurements and prediction in non- electrolytes and electrolytes, solubility of gases in liquids, Inter-phase mass transfer in two phase and multi component system.	(06)
Unit 2	**Mass transfer with Chemical reaction:** Fluid-fluid reactions involving diffusion transfer, application of mass transfer to reacting systems Residence time distribution analysis, mass transfer coefficients, determination and prediction in dispersed multiphase contractors under the conditions of free forced convection, prediction of mean drop or bubble size of dispersion.	(06)
Unit 3	**Contacting devices**: Capacity and efficiency, energy requirements of separation process. Extractive distillation, Reactive distillation, cryogenic distillation and molecular distillation.	(06)
Unit 4	**Multicomponent distillation:** Mass transfer models, Binary distillation in tray columns, Multicomponent distillation tray column, Distillation in packed column – Non-equilibrium models, solving the model equations, Design studies of De- propanizer.	(06)
Unit 5	**Adsorption, Ion exchange and chromatography:** Adsorption, equilibrium considerations, pure gas adsorption, liquid adsorption, Ion exchange equilibrium, equilibrium in	(06)

	chromatography, Kinetic and transport considerations, external and internal transport, mass transfer in ion exchange and chromatography.	
Unit 6	**Extraction:** Supercritical fluid extraction, Supercritical fluid, phase Equilibria, industrial applications, residuum oil Supercritical process – decaffeination of coffee, extraction of oil from seeds, residual oil Supercritical application (ROSE), Supercritical fluid chromatography.	(06)

Course Outcomes (CO): At the end of course students will

1. Define various operations like distillation, extraction, leaching, Compare and classify various mass transfer operations with or without chemical reaction
2. Design calculation of distillation column for the multi-component system
3. Analyze the problem of Separation by adsorption and design of absorber, chromatographic separation
4. Evaluate the separation by liquid extraction, leaching used and justify the extract operation to choose for specific problem
5. Estimate final data for designing number of stages, Height of column in the operations
6. Define various operations like distillation, extraction, leaching

Text Books

1	"Separation process" by J. Sieder and Henley, Wileypublishers,1998
2	"Principles of Mass Transfer and Separation Process" Binay K Datta, EEE, PHI Pvt Ltd.
3	"Unit operation in Chemical Engineering" 6TH edition, McCabe Smith, Mc Graw Hill
4	"Mass Transfer Operations" by Trebyal, McGraw Hill
5	"Mass Transfer Fundamentals and Applications", Anthony L. Hines & Maddox.

Reference Books

1	"Transport Separations and Unit Operations" 3rd edition, G.J.Geankoplis, Prentice Hall.
2	"Separation process" by C. Judson King, McGrawHill,1982
3	"Distillation" , Matther Van Winkle, Mc Graw Hill, Book Company

Useful Websites

1	Moocs/ Swayam/NPTEL Courses on Mass Transfer Operations I

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II

M. Tech. (Chemical Engineering), Sem.-II
2501PCHEPCC202 Chemical Process Control

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	01 hr/Week		ESE	60 Marks
Total Credits	04		TW Duration of ESE	25 Marks

Course Objectives (CO):

1. Develop structured, logical control schemes for complex processes.
2. Study dynamics of process and control behavior.
3. Choose control configurations for standard operations.
4. Estimate controller parameter setting.
5. Understand type of controller that can be used for specific problem in chemical industry.
6. Design digital control systems.

	Course Contents	**Hours**
Unit 1	Introduction To Feed Back Control: Concept of feedback Control, Types of feedback Controllers, Measuring Devises, Transmission Lines, Final Control Elements. Dynamic Behavior Of Feedback Control System: Block Diagram and closed looped response, effect of P Control, I Control, D Control, and Composite Control Action on response of a controlled process.	(06)
Unit 2	Mass transfer with Chemical reaction: Fluid-fluid reactions involving diffusion Stability Analysis Of Feedback System: Notion of Stability, the characteristics equation, Routh–Hurwitz Criterion for stability, Root locus analysis. Design Of Feedback Controller: Outline of Design Problem, Simple Performance Criteria, Time integral performance criteria, Select the type of feedback Controller, Controller tuning	(06)
Unit 3	Frequency Response Analysis Of Linear Process: Response of First Order System to Sinusoidal input, frequency response characteristics of a general linear system, Bode Diagram, Nyquist Plots. Design Of Feedback Control System Using Frequency Response Technique Bode Stability Criteria, Gain and Phase Margin, Ziegler- Nicholas Tuning Techniques, Nyquist Stability Criteria.	(06)

Unit 4	Feed Back Control Of System With Large Dead Time Or Inverse Response : Processes with Large dead time, Dead Time compensation, Control of System with Inverse response. Control System With Multiple Loop: Cascade Control, Selective Control System, Split Range Control.	(06)
Unit 5	Feed Forward And Ratio Control: Logic of Feed Forward Control, Problem of Designing feed forward controllers, Practical Aspect on Design of Feed forward controllers, Feed forward- Feed Back Control, Ratio Control. Adaptive and Inferential control system: Adaptive Control, Inferential Control Introduction To Plant Wide Control: Plant Wide Control issues, Hypothetical plant for Plant wide control Studies, Internal Feedback of Material and Energy, Interaction of Plant Design and control system design.	(06)
Unit 6	Plant Wide Control System Design: Procedures for Designs of Plant wide control systems, A Systematic procedure for plant wide control system design, Case studies: The Reactor Flash Unit Plant, Effect of Control Structure on Closed looped performance. Digital Process Control System: Hard ware and Software, Distributed Digital Control System, Analog and Digital Signals and Data transfer, Microprocessors and Digital Hardware in Process Control, Software Organization.	(06)

Reference Books

1	Chemical Process Control An Introduction To Theory And Practice- George Stephanopolous, Prentice Hall Of India , New Delhi2003
2	Process Dynamics And Control, Dale E Seborg, Yhomas F Edgar, Duncan A,Mellichamp- Wiley India2006
3	Process Control Modeling, Design And Simulation, B.Wayne Beqnette, Prentice Hall Of India, New Delhi2004

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II
Elective – IV

2501PCHEPE2031 Modern Reaction Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome:

CO1: To understand the principles of designing reactors

CO2: To evaluate reaction rates in different types of reactors

CO3: To understand the design and operation of catalytic reactors

CO4: To design and modify rectors to make processes safe and efficient

CO5: Analyze multiple reactions carried out both isothermally and non-isothermally in flow, batch and semi batch reactors to determine selectivity and yield.

CO6: Describe the steps in a catalytic mechanism and how one goes about deriving a rate law, mechanism, and rate-limiting step that are consistent with experimental data.

	Course Contents	**Hours**
Unit 1	A brief review of Chemical kinetics and Ideal reactor.	(06)
Unit 2	**Non-Ideal flow and mixing:** Mixing concept, RTD, Response measurement, segregated flow model, Dispersion model, Tank in Series model, recycle rector model, analysis non ideal reactor.	(06)
Unit 3	**Heterogeneous reaction:** Classification, Rate Controlling step, globale rate of reaction.	(06)
Unit 4	**Fluid-solid Non-Catalytic reaction:** Sinking core model, untreated core model, kinetics of non-catalytic reaction for spherical and cylindrical solid particles, Contacting patterns, Reactor design.	(06)
Unit 5	**Fluid-Fluid Reaction:** Gas-liquid reaction, practical ability of film theory, kinetic regime identification, kinetics of fluid-fluid reaction, Contacting patterns, Reactor design.	(06)
Unit 6	**Catalysis and Catalytic reaction:** Classification of catalysis, surface area measurement, BET theory, pore size distribution, adsorption, adsorption isotherm, Internal and External transport in pore catalyst, effectiveness factor and their modules, Effect of internal transport on selectivity, Catalyst deactivation, poison, Sintering of catalyst, and uniform posing model, Mechanism and kinetics of deactivation, catalyst regeneration. **Design of heterogeneous catalyst:** Isothermal and adiabatic fixed bed reactors, non-isothermal, non-adiabatic fixed bed reactor, Introduction to multiphase reactor design, two phase fluidized bed model, slurry reactor model, trickle bed reactor model.	(06)

Reference Books

1	Octave Levanspeil, Chemicaal Reaction Engineering, Jhon Wiley, London
2	S.M.Walas,ReactionKineticsforChemicalEngineers,McGrawHill,NewYark
3	J. M. Smith, Chemical Reaction Kinetics, Mc GrawHill,1981
4	Bischott and Fromment, Chemical Reactor Designandanalysis,Wesley-1982
5	Fogler H.S, Ellement of Chemical Reactionengineering,prantice-hall19863

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II

Elective – IV

2501PCHEPE2032Catalysis and Surface Phenomena

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome: -

CO1: To understand the concepts of homogenous and heterogeneous catalysis, catalytic activity and selectivity and the relevance to green chemistry and technology

CO2: To understand the kinetics of homogenous and heterogeneous catalytic reactions and catalytic cycles

CO3: To familiarize with the synthesis and characterization of catalysts

CO4: To understand the application and mechanisms of several types of catalysts

CO5: Knowledge of heat and mass transfer effects on catalytic reactions.

CO6: Ability to design different types of reactors for conducting catalytic reactions.

	Course Contents	**Hours**
Unit 1	**Introduction of Catalysis:** Classification of Catalysis - Homogeneous, Heterogeneous, Biocatalysts, Preparation of catalysis - Laboratory Techniques, Industrial methods, Transition models, Dual functional catalysts, Zeolites, Enzymes, Solid Catalysts, Powder Catalysts, Pellets, Composition, Active ingredients, Supportive materials, Catalysts activation.	(06)
Unit 2	**Catalysts Characterization:** Surface area measurements, BET Theory, Pore size distribution, Porosimetry Chemisorptions techniques, Static and dynamic methods, Crystallography and surface analysis techniques, XRD, XPS, ESCA, ESR, NMR, Raman and Masbauar spectroscopies, Surface acidity and toxicity, Activity, Lifetime, Bulkdensity, Thermal stability etc.	(06)
Unit 3	**Theories of Catalysts:** Crystal structure and its defects, Geometric and electronic factors, Analysis of transition model catalysis, Chemistry and thermodynamics of adsorption, Adsorption isotherms - Langmuir model, Tempkin model, Freundich model, Elovich equation, Langmiur Hinshel - wood model, Rideal - Eely mechanism, Reversible - irreversible mono and bimolecular reactions with and without inerts, Determination of rate controlling steps, Inhibition, parameter estimation.	(06)
Unit 4	**Mass and Heat Transport in Porous Catalysts:** Internal and external transport, fixed bed, Fluidized bed reactors, Effect of internal transport on selectivity. Effectiveness factor and Thiele modulus.	(06)

Unit 5	**Catalyst Deactivation:** Poisons, sintering of catalysts, Pore mouth plugging and uniform poisoning models, Kinetics of deactivation, Catalyst regeneration.	(06)
Unit 6	**Industrial Catalysis:** Industrial catalysts preparation methods, Typical industrial catalytic processes, Case studies, Catalytic deactivation prevention methods, New techniques for catalyst characterization, Overall study.	(06)

Reference Books	
1	Emmett, P.H. - "Catalysis Vol. I and II, Reinhold Corp.", New York,1954.
2	"Smith, J.M. - "Chemical Engineering Kinetics ", McGraw Hill,1971.
3	Thomas and Thomas - "Introduction to Heterogeneous Catalysts ", Academic Press, London 1967

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II

Elective – IV

2501PCHEPE2033 Down Stream Processing

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome:-

CO1: Understanding the fundamentals of downstream processing for biochemical product recovery.

CO2: Assessing the impact of change on overall process performance

CO3: Examining traditional unit operations, as well as new concepts and emerging technologies that are likely to benefit biochemical product recovery in the future.

CO4: Understanding analytical and process validation issues that are critical to successful manufacturing

CO5: Strategies for biochemical process analysis and synthesis.

CO6: Design and operation of unit processes with centrifugation, chromatography, filtration, and membrane processes

	Course Contents	**Hours**
Unit 1	**Requirement of Downstream Processing: Basic** concepts of separation Technology, Overview of a bioprocess including upstream and downstream processing, Importance of downstream processing in biotechnology, characteristics of biological molecules, New Separation process in modern biotechnology; Separation characteristics of proteins and enzymes – size, stability & other biological properties; Selection of purification methodologies, Characteristics of fermentation broth & its pretreatment.	(06)
Unit 2	**Biomass Removal and Disruption:** Biomass removal and disruption: Cell disruption by Mechanical and non-mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, Types of Homogenizers, Centrifugation; Sedimentation; Flocculation.	(06)
Unit 3	**Biomass Removal and Disruption:** Biomass removal and disruption: Cell disruption by Mechanical and non-mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, Types of Homogenizers, Centrifugation; Sedimentation; Flocculation.	(06)

Unit 4	**Membrane Based Separation:** Membrane based purification: microfiltration, Ultrafiltration, Reverse osmosis (UF and RO); Dialysis; Electrodialysis; Diafiltration; Pervaporation; Perstraction, Biotechnological application, Structure and characteristics of membranes; Liquid membranes; Supported liquid membrane; Membrane reactors. RO); Dialysis; Electro dialysis; Diafiltration; Pervaporation; Perstraction, Biotechnological application, Structure and characteristics of membranes; Liquid membranes; Supported liquid membrane; Membrane reactors.	(06)
Unit 5	**Separation by Adsorption and Chromatography:** Types of adsorption; adsorbents types, their preparation and properties, Types of adsorption isotherms and their importance; Chromatography: general theory, partition coefficients, zone spreading, resolution and plate height concept and other chromatographic terms and parameters; chromatographic method selection; selection of matrix; separation based on size, charge, hydrophobicity and affinity: Gel filtration, Ion exchange chromatography, Affinity chromatography, IMAC chromatography; Covalent chromatography; Reverse phase chromatography (RPC) and hydrophobic interaction chromatography (HIC), HPLC, role of HPLC in protein characterization; Chromato focussing; Polishing of Bioproducts by Crystallization of small and large molecules, drying and Formulations.	(06)
Unit 6	**Case Studies :**Baker's yeast, Ethanol, Power alcohol, Citric acid, Intracellular proteins, Penicillin, Streptomycin, Insulin, Casein, interferon, Large scale separation and purification of *E.coli*, yeast, Recombinant products.	(06)
	Reference Books	
1	E L V Harris and S. Angal, Protein Purification Methods, Ed. IRL Press at Oxford University Press,1989	
2	P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley-Interscience Publication,1988.	
3	J.E.Baileyand D.F.Ollis,BiochemicalEngineeringFundamentals,2nd Edition, Mc-Graw Hill, Inc.,1986	
4	ComprehensiveBiotechnology"Vol.2Ed.:M.Moo-Young(1985)	
5	Seperation, Recoveryand Purificationin Biotechnology, Aenjo J. A.and J. Hong	
6	Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamonpress (1984)	

7	"Biotreatment, Downstream Processing and Modeling" (Advances in Biochemical Engineering/Biotechnology, Vol 56) by T. Schepleretal, Springer Verlag
8	Downstream Processing" by J.P. Hamel, J.B. Hunter and S.K. Sikdar, American Chemical Society
9	Protein Purification" by M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical society,Verlag
10	Chromatographic and Membrane Processes in Biotechnology" by C.A. Costa andJ.S. Cabral, Kluwer, AcademicPublisher
11	Protein purification: Principle and practice, third edition, Robert k. Scopes, Springer,editor: Charles R.Cantor

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II
Elective – IV

2501PCHEPE2041 FLUID DYNAMICS

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome:-

CO1: Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems.

CO2: Understand solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly

CO3: Define and setup flow problem properly within CFD context, performing solid modelling and producing grids via meshing tool

CO4: Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution

CO5: Develop an awareness of the power and limitations of CFD.

CO6: Place CFD in the context of a useful design tool for industry and a vital research tool for thermos-fluid research across many disciplines.

	Course Contents	**Hours**
Unit 1	**Governing Differential Equation And Finite Difference Method :** Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference.	(06)
Unit 2	Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.	(06)
Unit 3	**Conduction Heat Transfer** Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems	(06)
Unit 4	**Incompressible Fluid Flow** Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.	(06)
Unit 5	**Convection Heat Transfer and Fem** Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one- dimensional convection – diffusion, Unsteady two-dimensional convection –Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation byFEM.	(06)

Unit 6	Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.	(06)
	Reference Books	
1	Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi,1995.	
2	Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd.,1998.	
3.	Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.	
4	Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier-Stokes Equation", Pineridge Press Limited, U.K.,1981.	
5	Anderson, D.A.,Tannehill,	
6	Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag,1987.	
7	Bose,T.X.,"NumericalFluidDynamics"NarosaPublishingHouse,1997	

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II
Elective – IV

2501PCHEPE2042 Energy Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome:-

CO1: Discuss and compare various types of energy resources and the principles for converting from one form to another.

CO2: Analyse and evaluate energy use over the lifecycle of a product or project.

CO3: Collect data from thermodynamic systems and evaluate the performance of the system.

CO4: Evaluate the global considerations of energy production, management and conservation including the environmental and economic impact of common fuels.

CO5: Understanding Energy management methods. Rational energy consumption. Energy conservation. Waste heat recovery.

CO6: Understanding Energy conservation in industry.

	Course Contents	**Hours**
Unit 1	Energy, units of energy, conversion factors, general classification of energy, Historical Events, Energy requirement of Society in Past and Present situation, World energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, future possibilities of energy need and availability, electrical energy from conventional energy resources, internal combustion engines, steam turbines, gas turbines, hydroturbines (thermodynamic cycles not included).	(06)
Unit 2	Nuclear reactors, thermal, hydel and nuclear power plants (process outlines only), efficiency, merits and demerits of the above power plants, combined cycle power plants, fluidized bed combustion, small hydropower.	(06)
Unit 3	Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooing, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar photovoltaic systems, solar cells, solar photovoltaic power generation, solar energy application in India, energy plantations, wind energy, types of windmills, types of wind rotors,	(06)
Unit 4	Darrieus rotor and Gravian rotar, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.	(06)
Unit 5	Biomass energy resources, thermochemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydro dynamics, open cycle and closed cycle systems, magneto hydro dynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage, electrical storage.	(06)

Unit 6	Energy conservation in chemical process plants, energy audit energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation in petroleum, fertilizer and steel industry, cogeneration, pinch technology, recycling for energy saving, electrical energy conservation in chemical process plants, environmental aspects of energy use.	(06)

Reference Books	
1	Goldmberg J., Johansson, Reddy A.K.N. & Williams R.H., Energy fora Sustainable World, JohnWiley
2	Bansal N.K., Kleeman M. & Meliss M., Renewable Energy Sources &Conversion Tech., Tata McGrawHill
3.	Sukhatme S.P., Solar Energy, Tata McGrawHill
4	Mittal K.M., Non-Conventional EnergySystems, WheelerPub
5	Venkata swarlu D., Chemical Technology, I, S.Chand
6	Pandey G.N.,ATextBookonEnergySystemand Engineering,VikasPub.
7	Rao S. & Parulekar B.B., EnergyTechnology, KhannaPub.
8	RaiG.D.,Non-ConventionalEnergySources,KhannaPub.
9	Nagpal G.R., Power Plant Engineering, KhannaPub.
Text Books	
1	Power Plant Engineering, P. K. Nag Tata McGraw Hill 2nd edn2001.
2	Power Plant Engineering, Domakundawar, Dhanpath Rai sons.2003

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

M.Tech. (Chemical Engineering), Sem.-II

2501PCHEPE2043 Advanced Separation Techniques

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome:-

CO1: Apply modern separation techniques in various applications.

CO2: To design a process based on separation principles.

CO3: Appropriate application of separation steps in industrial processes.

CO4: To compute the kinetics of various types of separation processes.

CO5: Analyze and design pervaporation, chromatography and dialysis-based separation processes.

CO6: Analyze and design novel membranes for intended application.

	Course Contents	**Hours**
Unit 1	**General** Review of Conventional process, recent advances in separation technique based on size, surface properties ionic properties and other special characteristics of substance.	(04)
Unit 2	**Filtration** Process Concept, Theory and Equipment used in Cross flow filtration, Cross flow electro filtration, duel functional filtration surface based solid- liquid separation involving stead liquid, Siroflocfilter.	(04)
Unit 3	**Membrane filtration** Types and choice of membranes, Plates and frame, tubular, Spherial wounded and hollow fibre membrane, reactor and their relative merits, commercial, pilot plant, and labortary membranes, Permeates involving analysis, reverse osmosis, nano filtration, ultrafiltration, microfiltration and donan analysis, economics of membrane operation, cevanic membrane.	(05)
Unit 4	**Separation by Adsorption technique** Mechanism, Choice and type of adsorbent, normal adsorption technique, affinity chromatography, and immune chromatography, types of equipment and commercial processes, recent advance and processes, Economics.	(05)
Unit 5	**Ionic Separation:** Controlling factor, application, type of equipment used in electrophoresis, dielectrophoresis, ion exchange chromatography, and electro-dialysis, commercial processes.	(05)
Unit 6	**Other technique:** Separation Involving lyophilisation, pervaporation and permeation technique for solid, liquid, and gases, industrial variables and examples, zone melting, add crystallization, other separation processes, supercritical fluid extraction, oil spillage management.	(05)

Reference Books

1	LaceyR.E andS.loaeb,industrial processing with membrane,wiely, newyark-1972
2	KingC.J,Separationprocesses,TataMc-Graw–hillpublicationCo.ltd-1982
3	Schoew, HM, New Chemical Engineering Separation technique, future sciencepublisher 1972
4	Ronald W.Ronssel,Hand book of process Technology, wilynewYork 198

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar				
First Year M.Tech. Chemical Engineering Semester- II				
2501PCHEOE2051 Project Management				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	40 Marks
Tutorials	----------		ESE	60 Marks
Total Credits	03		TW	----------
			Duration of ESE	.

Course Objectives : -
1 To study concept of Project Management and skills
2 Ability to understand organization structure
3 To acquaint with staffing the project office and team
4 Ability to understand controlling parameters and human behaviour
5 To study and develop a project scope
6 Ability to use CPM and PERT methods

	Course Contents	**Hours**
Unit 1	**Project Management growth** Concept and Definition, General System Management, Project management, Resistance to Change, System programmed, Project product vs project management a definition focus of success, Face of failure, Project life cycle, Project management methodologies, corporate culture	(05)
Unit 2	**Organizational structure** Introduction, organizational work flow, Traditional organization, developing work, integration position, Project coordinator, Projected organization, Matrix structure, Strong weak balanced matrix, Project management Expertise, Studying tips for the PMF (Project Management Certificate Exam)	(05)
Unit 3	**Organizing and staffing the project office and team** The staffing environment, Selecting the project manager, Skill requirement for project and programme manager, Organizational staffing progress, The project office, Project organizational chart.	(05)
Unit 4	**management function** Controlling, Directing, Project Authority, Interpersonal life cycle, leadership in a project management environment, life cycle leadership, organizational impact , employee manager problem, management pitfalls, Communication, Human behavior education, Management policies and procedure.	(05)

Unit 5	**Special Topic** Performance measurement, Financial compensation and rewards, Critical Issues with rewarding project team, mega Project, Morality, Ethics and corporate culture.	(05)
Unit 6	**Special Topic -Cont** Professional Responsibility, Internal Prternership , External Prternership, Training and education, Integrated project steam, Virtual project team, Break through	(05)

Course Outcomes (CO): At the end of course students will
1. Define various operations like distillation, extraction, leaching, Compare and classify various mass transfer operations with or without chemical reaction
2. Design calculation of distillation column for the multi-component system
3. Analyze the problem of Separation by adsorption and design of absorber, chromatographic separation
4. Evaluate the separation by liquid extraction, leaching used and justify the extract operation to choose for specific problem
5. Estimate final data for designing number of stages, Height of column in the operations
6. Define various operations like distillation, extraction, leaching

Text Books

1	"A system Approach to planning, Scheduling, Controlling, by Harolad Kerzner 10th Ed Willy

Reference Books

1	Project Management Theory and Practices Crary L Richardsion, CRC press, Taylor and Franas Group, boca ration London, Newyark
2	Project Management for Engineer business, technology 4th Ed, Jhon M Nicholas,Herman

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II

2501PCHEOE2052 Operations Research

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome:-

CO1: Identify and develop operational research models from the verbal description of the real system.

CO2: Understand the mathematical tools that are needed to solve optimization problems.

CO3: Use mathematical software to solve the proposed models

CO4: Develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

CO5: Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.

CO6: Define and formulate linear programming problems and appreciate their limitations.

	Course Contents	**Hours**
Unit 1	Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions	(06)
Unit 2	Transportation Problem. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.	(06)
Unit 3	Assignment model. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem.	(06)
Unit 4	Sequencing models. Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.	(06)
Unit 5	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	(06)

Unit 6	Games Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	(06)
Text Books		
1	P. Sankara Iyer, “Operations Research”, Tata McGraw-Hill,2008.	
2	A.M. Natarajan, P. Balasubramani, A. Tamilarasi, “Operations Research”,Pearson Education,2005.	
Reference Books		
1	JKSharma.,“OperationsResearchTheory&Applications,3e”, Macmillan India Ltd,2007.	
2	P. K. Gupta and D. S. Hira, “Operations Research”, S. Chand & co.,2007.	
3	JKSharma.,“Operations Research,Problems and Solutions,3e”, Macmillan India Ltd.	
4	N.V.S. Raju, “Operations Research”, HI-TECH,2002.	

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II

2501PCHEOE2053 Energy Technology

Teaching Scheme			Examination Scheme	
Lectures	03 Hrs/Week		CIE	40 Marks
Tutorials	--		ESE	60 Marks
Total Credits	03		TW	--
			Duration of ESE	.

Course Outcome:-

CO1: Explain the global and Indian energy scenario, and distinguish between conventional and renewable energy resources.

CO2: Comprehend the working principles and components of conventional power plants

CO3: Analyze solar energy systems (thermal and photovoltaic) and evaluate their performance for different applications.

CO4: Compare wind, biomass, and other renewable technologies in terms of feasibility, resource availability, and technology challenges.

CO5: Apply concepts of energy storage, hydrogen energy, and fuel cells to propose suitable energy solutions.

CO6: Conduct a basic energy audit and recommend energy management strategies for improving efficiency in industries and buildings.

	Course Contents	Hours
Unit 1	**Introduction** Classification of energy resources: renewable vs. non-renewable, Global & Indian energy scenario, Energy demand and supply projections, Environmental impact of energy use.	(06)
Unit 2	**Conventional Energy Conversion Systems** Thermal Power Plants: Rankine cycle, steam generators, turbines, condensers. Hydro Power Plants: site selection, classification, turbines. Nuclear Energy: fission, reactors, nuclear fuel cycle, safety. Fossil Fuels: coal, oil, natural gas – formation, properties, utilization	(06)
Unit 3	**Solar Energy Technology** Solar radiation – measurement and estimation, Solar thermal collectors (flat plate, concentrating). Solar PV systems – working principle, I-V characteristics, modules & arrays. Applications: water heating, drying, solar cookers, grid-connected PV.	(06)
Unit 4	**Wind, Biomass & Other Renewables** **Wind Energy**: principles, wind turbines, site selection, wind farms. **Biomass**: resources, combustion, gasification, digestion, biofuels. **Other Sources**: tidal, wave, geothermal, ocean thermal, small hydro.	(06)
Unit 5	**Energy Storage & Emerging Technologies** Electrical storage: batteries, supercapacitors. Mechanical storage: flywheels, pumped hydro, compressed air. Hydrogen energy & fuel cells. energy systems and smart grids.	(06)

Unit 6	**Energy Management, Audit & Policy (8 hrs)** Energy conservation principles and practices.Energy efficiency in industries and buildings. Energy audit – methods and instrumentation, National energy policies, renewable energy programs in India.	(06)

Text Books	
1	Energy Resources and Technology – S.P. Sukhatme & J.K. Nayak.
2	Power Plant Engineering – P.K. Nag.
Reference Books	
1	Solar Energy: Principles of Thermal Collection and Storage – S.P. Sukhatme & J.K. Nayak.
2	Renewable Energy Sources and Emerging Technologies – D.P. Kothari, K.C. Singal & Rakesh Ranjan.
3	Fuel Cells: Principles and Applications – B.V. Mehta & S.S. Sharma.
4	Energy Engineering and Management – Amlan Chakrabarti.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Chemical Engineering Semester- II Practical

2501PCHELC206 Analytical Laboratory

Teaching Scheme			**Examination Scheme**	
Practical's	04 hr/Week		ESE	--
Total Credits	02		TW	25 Marks
			Duration of ESE	

Course Outcome:-

CO1: Apply mathematical, physical and chemical concepts to routine tasks such as the analysis and synthesis of chemical compounds and samples.

CO2: Describe and understand the capabilities and limitations of instrumental methods

CO3: Demonstrate competence in collecting and interpreting data in the laboratory.

CO4: Apply principles of chemistry to the observations of substances experiencing physical or chemical changes.

CO5: Laboratory skills for the purpose of collecting, interpreting, analyzing, and reporting (in written form) chemical data.

CO6: Conduct basic manual quantitative and qualitative analyses accurately, using prescribed laboratory procedures.

Course Contents

1. Analysis Of Given Sample by using Gas Chromatography
2. Detail study and Analysis of High-Performance Liquid Chromatography (HPLC)
3. Instrument Exploration: Scanning Electron Microscopy (SEM)
4. Measurement, analyze, and discussion of three different types of Samplevia Thermo gravimetric Analysis, or TGA
5. Determination of the amount of carbon monoxide in exhaust samples by FTIR spectroscopy
6. Spectrophotometry: Absorption spectra and the use of light absorption to measure concentration

7 Analysis by using Gel Electrophoresis

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Chemical Engineering) Semester- II

2501PCHELC206 Seminar – II

Teaching Scheme			Examination Scheme	
Lectures	----		ISE	---
Tutorials	---		ESE (Oral)	---
Practical	02Hrs/Week		TW	50
Total Credits	01		Duration of ESE	------.

Course Objectives (CO):

1.To Identify, understand and discuss current, real-world issues.

2.To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g., humanities and sciences) with that of the student's own academic discipline (e.g., in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.). and apply a multidisciplinary strategy to address current, real-world issues.

3. To Improve oral and written communication skills.

4. To Improve presentation skills

	Course Contents	Hours
1	Seminar II shall be based on tentative topic of dissertation such as review paper on some specific well defined area/ specialized stream of Mechanical Engineering. Each student has to prepare a write up of about 25-30 pages of "A4" size sheets and submit it in IEEE format in duplicate as the term work.The student has to deliver a seminar talk in front of the faculty of the department and his classmates. The faculty, based on the quality of work, carried out, preparation and understanding of the candidates. Some marks should be reserved for the attendance of a student in the seminars of other students.	(--)

Course Outcomes (CO): At the end of course students will

1. Apply principles of ethical leadership, collaborative engagement, socially responsible behavior, respect for diversity in an interdependent world, and a service-oriented commitment to advance and sustain local and global communities.

2. Learn and integrate. Through independent learning and collaborative study, attain,
use, and develop knowledge in the arts, humanities, sciences, and social sciences, with disciplinary specialization
nd the ability to integrate information across disciplines.

3. Think and create. Use multiple thinking strategies to examine real-world
issues, explore creative avenues of expression, solve problems, and make consequential decisions

4.Communicate. Acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication that demonstrates respect and understanding in a complex society.

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