Shree Warana Vibhag Shikshan Mandal's

WARANA UNIVERSITY,
WARANANAGAR

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

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Warana University

Established: 2025

Structure & Syllabus For
First Year Master of Technology (F.Y. M.Tech)
In
Chemical Engineering

UNDER

Faculty of Science & Technology

(As Per National Education Policy – 2020)

With Effect from Academic Year 2025-26 Onwards

Shree Warana Vibhag Shikshan Mandal's

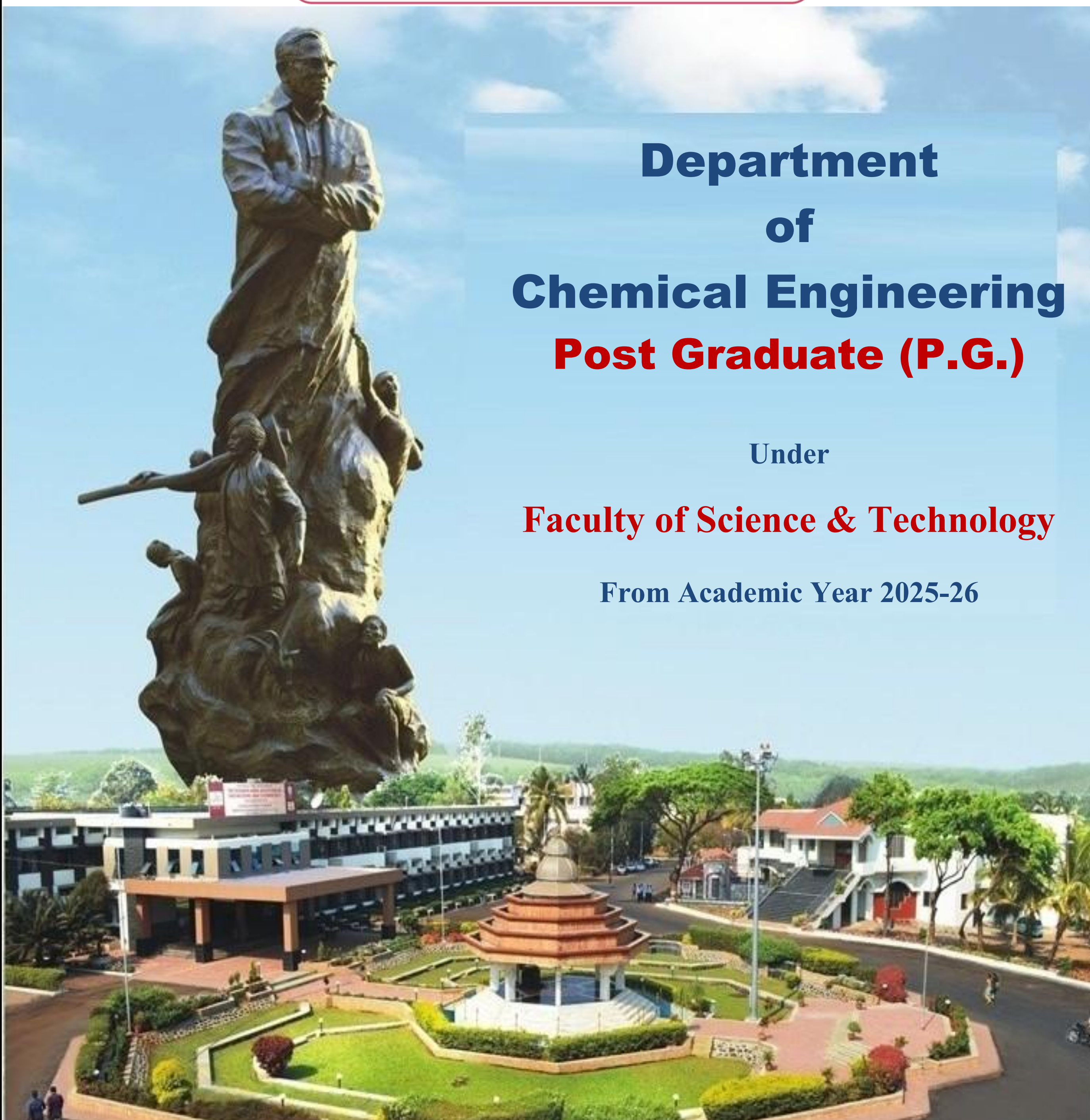
TATYASAHEB KORE INSTITUTE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS), WARANANAGAR, KOLHAPUR

Estd. 1983

Lead Institute of

WARANA UNIVERSITY, WARANANAGAR

(A State Public University)



Department of Chemical Engineering

Post Graduate (P.G.)

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

Contents

Preface

The National Education Policy (NEP) 2020 has introduced transformative reforms in India's higher education system, emphasizing multidisciplinary learning, research and innovation, skill enhancement, flexibility in curriculum, and strong industry–academia collaboration. In alignment with these progressive reforms, Tatyasaheb Kore Institute of Engineering & Technology (TKIET), Warana University, Warananagar, is committed to implementing NEP 2020 in its true spirit to develop technically competent, ethically responsible, and socially conscious chemical engineers.

The Department of Chemical Engineering is pleased to present the syllabus for the M.Tech Programme in Chemical Engineering, meticulously designed in accordance with NEP 2020 guidelines and emerging industrial, research, and societal needs. The programme aims to provide advanced knowledge in core and emerging areas such as process design, advanced reaction engineering, process modelling and simulation, advanced separation processes, energy systems, sustainability, and modern computational tools.

The curriculum emphasizes research orientation, innovation, critical thinking, environmental responsibility, and industry relevance. It integrates theoretical depth with practical exposure through laboratory work, seminars, internships, and dissertation projects. Special focus is placed on sustainable process development, green technologies, safety, and digital transformation in chemical industries.

This syllabus provides comprehensive details regarding course structure, credit distribution, learning outcomes, evaluation methodology, research components, and academic regulations to ensure effective implementation of the programme. The Department sincerely acknowledges the valuable contributions of the Board of Studies members, academic experts, and industry professionals who have played a significant role in shaping this curriculum.

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Program Outcomes

Program Outcomes (POs) are clear, measurable statements that describe what students are expected to know, understand, and be able to do by the time they complete an academic program. They define the competencies, skills, and professional abilities that graduates should possess at the end of the program. In India, POs for Engineering Programs are formally prescribed and monitored by the National Board of Accreditation (NBA). NBA has defined the following three POs for a graduate of PG Engineering Program:

PO1:	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2:	An ability to write and present a substantial technical Report/document.
PO3:	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Duration

- The full time M. Tech Program is a 2 years post graduate program.
- The program is divided into 4 semesters.

Eligibility

1. The Candidate should be an Indian National.

2. Passed Bachelor's Degree in the relevant field of Engineering & Technology from AICTE or Central or State Government approved institutions or equivalent, with at least 50% marks (at least 45% marks in case of candidates of Backward Class categories, EWS and PWD).

3. Obtained Qualified score or non-qualified score in GATE conducted by the IIT for the current academic year.

OR

3. For sponsored candidates (Proforma P and Q), a minimum of two years of full-time work experience in a registered firm/ company/ industry/ educational and/ or research institute/ any Government Department or Government Autonomous Organization in the relevant field in which admission is being required.

Medium of Instruction

- The medium of instruction, examinations, assignments, and project reports is English.

Abbreviations

Acronym	Full Form
ISE	In-Semester Examination
ISE-I	In-Semester Examination I
ISE-II	In-Semester Examination II
ESE	End Semester Examination
ISA	In Semester Assessment
POE	Practical Oral Examination
L	Theory Lecture
T	Tutorial
P	Practical
C	Number of Credits
CH	Contact Hours
PCC	Program Core Course
PE	Program Elective Course
LC	Lab Course
OE	Open Elective Course
SW	Seminar Work
CV	Comprehensive Viva

Examination & Evaluation Pattern

Evaluation tools used for the evaluation of a student for each course is as follows:

For Theory Courses	In-Semester Examination (ISE) And End Semester Examination (ESE)
For Lab / Tutorial Courses	In-Semester Assessment (ISA) And / Or Practical and Oral Examination (POE)

Refer course structure for specific evaluation tools used for each course.

In-Semester Examination (ISE)

The In-Semester Examination (ISE) will be conducted at the departmental level. There will be two tests in each semester for every theory course: ISE-I and ISE-II.

- Each test will be of 40 marks.
- The duration of each test will be 1 hour and 30 minutes.

The total ISE marks will be calculated as the average of ISE-I and ISE-II. These rules may be modified from time to time as per the guidelines of the concerned regulatory authorities.

- ISE-I will cover Unit I and Unit II.
- ISE-II will cover Unit III and Unit IV.

  - **Minimum Passing Criteria**

    Students must score a minimum of 40% marks in the ISE. If a student fails to secure the minimum required marks, he/she must appear for a Make-up Examination.

    The Make-up Examination will be conducted in the same semester for:

    - Students who fail to secure minimum passing marks.
    - Students who were absent due to valid reasons such as medical issues, natural calamities, or participation in NSS, NCC, or similar activities (subject to verification of absence and recommendation from the Head of Department).

- **Special Provision**

  If a failed student appears for three tests (including the Make-up test) and scores more than 16 marks when calculating the average of the best two out of the three tests, the student will be awarded the minimum passing marks of 16 only.

  For students absent with valid reasons:

  - If absent in one test, the average of the attempted test and the Make-up test will be considered.
  - If absent in two tests, the decision will be taken after reviewing the reasons and based on the recommendation of the Head of Department.

End Semester Examination (ESE):

The End Semester Examination (ESE) will be conducted for 60 marks and will be based on the entire syllabus. The duration of each examination will be 2 hours.

Weightage of Units

The weightage of units in the ESE question paper will be as follows:

a) Units that are not covered in ISE-I or ISE-II will carry 30% weightage each.

b) Units that are covered in ISE-I and ISE-II will carry 10% weightage each.

Backlog Examination

Students who fail in the End Semester Examination (ESE) of either the odd or even semester within an academic year will be allowed to appear for the Backlog Examination, which will be conducted along with the regular ESE of the respective semester.

- **Re-Examination of ESE**

  A Re-Examination (Make-up Examination) for all courses (UG and PG), including both theory and laboratory courses, will be conducted once a year before the commencement of the odd semester of the next academic year.

  - A one-grade penalty will be applied to students appearing for the Make-up/Re-Examination.
  - However, no grade penalty will be applied if a student secures a ‘P’ grade in the Make-up/Re-Examination.
  - Grace marks will not be awarded for the Make-up/Re-Examination.
  - Exception: Grace marks may be considered if the student is appearing for the ESE for the first time.

- **Eligibility Criteria for ESE**

  To be eligible for the End Semester Examination (ESE), a student must:

  - Secure at least 40% marks in ISE and ISA of the concerned course.
  - Fulfil the attendance requirements as per the norms of Warana University, Warananagar.

  If a student does not meet these requirements, he/she will not be eligible to appear for the ESE.

Nature of Question Paper for ESE

Q. No.			Marks	BL	CO
1	**Attempt the following.**		24		
	a	Unit -1		II	1
	b	Unit -2		III	2
	c	Unit -3		IV	1
	d	Unit -4		I	1
2	**Attempt any Two of the following.**		18		
	a	Unit -5		VI	2
	b	Unit -5		II	3
	c	Unit -5		IV	3
3	**Attempt any Two of the following.**		18		
	a	Unit -6		IV	4
	b	Unit -6		III	4
	c	Unit -6		III	4

In Semester Assessment (ISA):

ISA for laboratory courses will be conducted as a continuous assessment throughout the semester. The assessment will be based on the following:

1. Performance in laboratory work.
2. Submission of experiments in the form of a properly maintained journal or report.
3. Timely completion of assigned experiments.
4. Attendance in laboratory sessions.

5. Understanding of the experiments conducted, evaluated through methods such as quizzes, oral examinations, case studies, field work, surveys, open-book tests, model preparation, programming, projects, or any other criteria specified by the course teacher.

Practical Oral Examination (POE):

POE for laboratory courses will be conducted immediately after the end of the semester. The duration of the practical examination will be as specified in the curriculum structure. The POE will be conducted jointly by an Internal Examiner and an External Examiner.

The examination may be conducted in any one of the following ways:

1. **Oral Examination Only**

   Both the Internal and External Examiners will ask questions based on the practical content of the course to assess the student's practical knowledge.

2. **Practical Examination Only**

   Students will be required to perform a given experiment, complete a workshop task, prepare a drawing, or develop a computer program, as applicable. In this case, the student's performance will be evaluated by the External Examiner only.

3. **Practical and Oral Examination**

   Students will first perform a given practical task. This will be followed by an oral examination (viva voce) based on the practical content of the course. The student's performance will be evaluated jointly by both the Internal and External Examiners.

Grading System

The University follows a **10-Point Grading System** to evaluate student performance.

- **Conversion of Marks into Grades**
  In every semester, the marks you get in each subject (out of 100) are converted into **grade points** as per the table below. You need at least **40% marks** to pass a subject.

Marks Obtained (Out of 100)	Grade Point	Letter Grade	Meaning
Absent	0	AB	Absent
0 – 39	0	F	Fail
40 – 44	4	P	Pass
45 – 49	5	C	Average
50 – 59	6	B	Above Average
60 – 69	7	B+	Good
70 – 79	8	A	Very Good
80 – 89	9	A+	Excellent
90 – 100	10	O	Outstanding

Note:

1. If decimal marks are 0.5 or more, they will be rounded off to the next higher number. (Example: 59.5 will become 60)
2. For courses of 50 marks or 200 marks, marks will be converted proportionally to 100 marks before assigning grade points.

- **Calculation of Semester Grade Point Average (SGPA)**
  SGPA is calculated at the end of each semester**.** It shows your average performance in one semester.

$$SGPA = \frac{\sum(Credit \times Grade\ Point)\ for\ each\ course\ of\ a\ Semester}{\sum(Credits)\ for\ a\ Semester}$$

- **Calculation of Cumulative Grade Point Average (CGPA)**
  CGPA is calculated after completing multiple semesters. CGPA reflects the overall academic performance of the student in the program.

$$CGPA = \frac{\sum(Total\ Credits\ of\ a\ Semester \times SGPA\ of\ Respective\ Sememster)\ of\ all\ semesters}{\sum(Course\ Credits)\ of\ all\ Semesters}$$

Note:

1. The SGPA & CGPA shall be rounded off to 2 decimal points.

First Year M. Tech. Chemical Engineering

Curriculum Structure & Evaluation Scheme for Semester-I

Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
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
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	
LC	2501PCHE LC106P	Advanced Separation Laboratory	-	-	4	2	4	POE	25	10	20
								ISA	25	10	
SW	2501PCHE SW107T	Seminar-I	-	-	2	1	2	ISA	50	20	20
Total			15	2	6	20	23		650	260	260

Note: 'X' indicates the sequence number of PE/OE offered by the respective department.

First Year M. Tech. Chemical Engineering

List of Program Electives for 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

First Year M. Tech. Chemical Engineering

Curriculum Structure & Evaluation Scheme for Semester-II

Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
PCC	2501PCHEPCC201	Advanced Mass Transfer	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PCHEPCC201T	Advanced Mass Transfer Tutorial	--	1	--	1	1	ISA	25	10	10
	2501PCHEPCC202	Chemical Process Control	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PCHEPCC202T	Chemical Process Control Tutorial	--	1	---	1	1	ISA	25	10	10
PE	2501PCHEPE203X	Program Elective-IV	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PCHEPE204X	Program Elective-V	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
OE	2501PCHEOE205X	Open Elective Course	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
LC	2501PCHELC206T	Analytical Laboratory	--	--	2	1	2	ISA	25	10	10
SW	2501PCHESW207T	Seminar-II	--	--	2	1	2	ISA	50	20	20
CV	2501PCHECV208P	Comprehensive Viva	--	--	2	1	2	POE	25	10	10
Total			**15**	**2**	**6**	**20**	**23**	**--**	**650**	**260**	**260**

Note:

- 'X' indicates the sequence number of Program Elective (PE) offered by Computer Science and 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 Electives for 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. Chemical Engineering

List of Open Electives Offered by All Programs

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 and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPCC101 Course Name: Advanced Momentum and Heat Transfer

Teaching Scheme	Credit	Evaluation Scheme	
Lectures: 03 Hours/Week Tutorial: 01/Hours/Week	04	ISE:	40 Marks
		ESE:	60 Marks
		TW:	25 Marks

Prerequisites, if any:

Knowledge of following subject is required

1. Heat transfer
2. Fluid Mechanics

Course Objectives: The objective of the course is to

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 Outcomes: After successful completion of the course, student will be able to

CO1	Able to understand the chemical and physical transport processes and their mechanism
CO2	Able to do heat, mass and momentum transfer analysis
CO3	Able to analyze industrial problems along with appropriate approximations and boundary conditions
CO4	Able to develop steady and time dependent solutions along with their limitations
CO5	Understand the concepts of boundary layer and its estimation in different flows
CO6	Understanding of various types of heat transfer process and devices

Course Description:

Advanced Momentum and Heat Transfer focuses on the rigorous analysis of transport phenomena governing fluid flow and heat transfer in engineering systems. The course builds upon fundamental transport concepts and develops mathematical formulations for complex laminar and turbulent flow, convective heat transfer, and coupled transport processes.

Course Content		
Unit-1	**Boundary Layer Flow**	**(6 Hours)**
Boundary Layer Flow: Boundary layer equations, separation of BL, Blasius solution for flat state, properties of BL equation, Momentum integral equations.		
Unit-2	**Turbulent Flow**	**(6 Hours)**
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.		
Unit-3	**Agitation and mixing**	**(6 Hours)**
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 energy relations. Motion in The Fluidized Bed: Bubbling fluidization, semi-fluidization, mixing and segregation in fluidized bed, Numerical and application of fluidization		
Unit-4	**Introduction**	**(6 Hours)**
Introduction: Review of heat Transfer, transient 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.		
Unit-5	**Heat Transfer in Two Phase Systems**	**(6 Hours)**
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.		
Unit-6	**Heat Transfer Augmentation**	**(6 Hours)**
Active and passive techniques, rough surface, swirl flow generation and compound augmentation. Compact heat exchangers. Introduction of Pinch Analysis and Process integration.		
Learning Resources:		

Text Books
1) R.B. Bird, W.E. Stewart and E.N. Lightfoot, ―Transport Phenomena , John‖ Wiley & Sons, Inc, New York 2) C.J. Geankoplis" Transport Processes Momentum And Mass" Bacon Inc
Reference Books
1) Chemical Engineering" by Coulson and Richardson, Volume I

Tatyasaheb Kore Institute of Engineering and Technology First Year M. Tech Chemical Engineering				
Course Code: 2501PCHEPCC102 Course Name: Advanced Chemical Engineering Thermodynamics				
Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	03 Hours/Week	04	ISE:	40 Marks
Tutorial	01 Hours/Week		ESE:	60 Marks

Prerequisites, if any:

Knowledge of following subject is required

1. Thermodynamics
2. Heat transfer

Course Objectives: The objective of the course is to

1. To develop advanced understanding of classical thermodynamics including rigorous treatment of the First and Second Laws and their mathematical formulation.
2. To analyze thermodynamic properties of pure substances and mixtures using equations of state and activity coefficient models.
3. To apply thermodynamic principles to phase and chemical equilibrium in multi- component systems.
4. To evaluate real system behaviour using fugacity, chemical potential, and residual properties.
5. To understand and apply thermodynamics of reacting systems, including equilibrium constant calculations and Gibbs free energy minimization.
6. To analyze exergy and availability concepts for assessing efficiency and irreversibility in engineering systems.

Course Outcomes: After successful completion of the course, student will be able to

CO1	Define & describe the basic laws of thermodynamic
CO2	Explain the criteria for equilibrium with stability of thermodynamic system.
CO3	Develop skills to make appropriate assumptions and ability to predict intermolecular potential and excess property behavior of multi- component systems.
CO4	Analysis & estimation of the Gibbs free energy and fugacity of a component in mixture
CO5	Judge the Chemical equilibrium and evaluate the degrees of freedom for chemically reacting systems
CO6	Discuss statistical thermodynamic terms.

Course Description:

Advanced Thermodynamics provides an in-depth study of thermodynamic principles and their application to complex engineering systems. The course extends classical thermodynamics to multicomponent, multiphase, and chemically reacting systems. Emphasis is placed on the rigorous mathematical formulation of thermodynamic laws, property estimation methods, and equilibrium criteria.

Course Content

Unit-1	**Detailed review of thermodynamics laws and basic concepts**	**(6 Hours)**
Laws of thermodynamics, Concepts of entropy, Intensive and extensive variables, Enthalpy, Gibbs free energy, Equations of state, other important thermodynamic properties.		
Unit-2	**Equilibrium and Stability in one component system**	**(6 Hours)**
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.		

Unit-3	**The Thermodynamic of Multi Component Mixtures**	**(6 Hours)**
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).		
Unit-4	**The estimation of the Gibbs free energy and fugacity of a component in mixture:**	**(6 Hours)**
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.		
Unit-5	**Chemical Reaction equilibrium**	**(6 Hours)**
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		
Unit-6	**Introduction to Statistical thermodynamics**	**(6 Hours)**
Qantum considerations, Microstates, Macrostates and thermodynamic probability, Physical models, Boltzmann statistics, Fermi– Dirac statistics and Bose – Einstein statistics, Partition function, Phase space		
Learning Resources:		
Text Books **1)** Chemical Engineering Thermodynamics – Stanlay Sandler IInd edition Wiley graham in chemical engineering. **2)** Chemical Engineering Thermodynamics K.V.Narayanan **3)** Chemical Engineering Thermodynamics T. E. Daubert		
Reference Books **1)** Chemical Engineering thermodynamics", Y. V. C. Rao		
MOOC / NPTEL/YouTube Links **1)** http://nptel.ac.in/ **2)** http://swayam.gov.in/		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering
Course Code: 2501PCHEPE1031 Course Name: Process Modeling in Chemical Engineering

Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	03 Hours/Week	03	ISE:	40 Marks
			ESE:	60 Marks

Prerequisites, if any:
Knowledge of following subject is required
1. Process control
2. Process simulation

Course Objectives: The objective of the course is to
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 Outcomes: After successful completion of the course, student will be able to

Course Description:
The Process Modeling in Chemical Engineering course focuses on the development, analysis, and application of mathematical models to represent chemical processes. The course emphasizes translating physical and chemical phenomena into mathematical equations using principles of mass balance, energy balance, momentum balance, and reaction kinetics.

Course Content

Unit-1	Introduction to dynamic models	(6 hours)

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.		
Unit-2	**Mass transfer models**	**(6 hours)**
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.		
Unit-3	**Lumped and distributed system**	**(6 Hours)**
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.		
Unit-4	**Flow sheet simulation**	**(6 Hours)**
Process flow sheet simulation, Process and information matrix, Materials and Energy balance computation using modular approach, Process analysis, Process variables, selection, Equipment selection.		
Unit-5	**Dynamic simulation**	**(6 Hours)**
Dynamic simulation of Reactors, distillation column, Absorbers, evaporators and crystallizes, introduction to simulation packages like GPSS, CSMP.		
Unit-6	**Process Simulators:**	**(6 Hours)**
Introduction to professional simulator like UNISIM, Aspen. Mathematical tools like SciLab, Introduction to Solver and Poly Math etc.		
Learning Resources:		
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)** R. W. Gaikwad, Dr. Dhirendra, “Process Modeling and Simulation”, Central Techno Publications, Nagpur, 2003.		
Reference Book **1)** R. W. Gaikwad, Dr. Dhirendra, “Process Modeling and Simulation”, Central Techno Publications, Nagpur, 2003. **2)** Roger G. E. Franks, “Modeling and Simulation in Chemical Engineer”, Wiley Inter Science, New York, 1972.		
1. Moocs/ Swayam Courses on Process Modeling & Simulation in Chemical Engineering, OpenModelica		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE1032 Course Name: CORROSION ENGINEERING

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:
Knowledge of following subject is required
1. Material science

Course Objectives: The objective of the course is to
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 Outcomes: After successful completion of the course, student will be able to

CO1	1. Define fundamentals of Corrosions.
CO2	2. Apply the Corrosion measurement techniques.
CO3	3. Recognize Mechanisms of corrosion.
CO4	4. Solve the problems related to the environmental impact of corrosion.
CO5c	5. Analyze the problem and its preventive actions.

Course Description:

Course Content

Unit-1	**Basic concepts**	**(6 Hours)**

Definition and importance, Electrochemical nature and forms of corrosion, Corrosion rate and its determination.

Unit-2	**Electrochemical thermodynamics and kinetics**	**(6 Hours)**

Electrode potentials, Potential-pH (Pourbiax) diagrams, Reference electrodes and experimental measurements, Faraday's laws, Instrumentation and experimental procedure

Unit-3	**Corrosion measurement through polarization techniques**	**(6 Hours)**

Tafel extrapolation plots, Polarization resistance method, Commercial corrosion probes, Other methods of determining polarization curves.

Unit-4	**Pitting and crevice corrosion**	**(6 Hours)**

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.

Unit-5	Environmental induced cracking	(6 Hours)
Stress corrosion cracking, Corrosion fatigue cracking, Hydrogen induced cracking, Methods of prevention and testing, Erosion, Fretting and Wear.		
Unit-6	**Environmental factors and corrosion**	**(6 Hours)**
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.		
Learning Resources:		
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 and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE1033 Course Name: Polymer and Rubber Technology

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any: Knowledge of following subject is required
1. Chemistry
2. Basics of polymer

Course Objectives: The objective of the course is to
1) Define & describe the basics of polymer and rubber. 2Explain the criteria for the polymerization process.
2) Develop skills to understand and study various processes of polymer and rubber production.
3) To understand the advances in polymer and rubber technologies.
4) To prepare the students to take challenges of polymer field in his profession.

Course Outcomes: After successful completion of the course, student will be able to

CO1	Understand polymer and rubber processing
CO2	Formulate and analyse specific polymer & rubber Engineering problems using fundamental concepts.
CO3	Select appropriate approximations for practical problem solving.
CO4	Understand the future of polymer & rubber industry in Indian context.
CO5	Understand advanced processes

Course Description:

Course Content

Unit-1	**Polymerization Fundamentals**	**(6 Hours)**

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.

Unit-2	**Manufacture of industrially important polymers for Plastics**	**(6 Hours)**

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,

Unit-3	**Manufacture of industrially important polymers for Synthetic fibers**	**(6 Hours)**

Introduction, Classification, properties and preparation, Nylon -6, Nylon – 66, Rayon, Silicones, Poly silicones, Orlan, Saron, Teflon, Cellulose, and its derivatives.		
Unit-4	**Manufacture of rubber and elastomers**	**(6 Hours)**
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, Silicone Rubber, Polyurethane rubber, Spandex, Sponge rubber, Foam rubber, Laminates, Rubber cement.		
Unit-5	**Processing and manufacture of rubber products**	**(6 Hours)**
Vulcanizing, Compounding, Rubber chemicals, Processing equipment and method, Tyres and tubes manufacture, Reclamation of rubber, Applications of rubber.		
Unit-6	**Polymer and rubber industries in India**	**(6 Hours)**
Development and scope of plastics, Synthetic Fibre, and elastomer industry in India.		
Learning Resources:		

Text Books

1) G.S. Misra, ―Introductory Polymer Chemistry‖, Wiley Eastern 2) 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
2) Engineering‖, Wiley, 1978.
3) D.J. Williams, ―Polymer Science and Engg‖. Prentice Hall, New York 1971.
4) 4 F. Rodrigues, ―Principles of Polymers systems‖, McGraw Hill, New York 1970

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE1041 Course Name: Nanotechnology

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:

Course Objectives: The objective of the course is to

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

Course Outcomes: After successful completion of the course, student will be able to

CO1	To understand the application of Nanoscience in catalysis and green chemistry.
CO2	Demonstrate the understanding of length scale concepts, nanostructures and nanotechnology.
CO3	Characterization of nanomaterials.
CO4	Physico chemical aspects of different types of nanostructures.
CO5	Systematically solve scientific problems related specifically to nano- technological materials using conventional scientific and mathematical notation
CO6	Identify the principles of processing, and synthesis of nanomaterials and nanostructures

Course Description:

Course Content

Unit-1	**Introduction to Nanotechnology**	**(6 Hours)**
History, Importance of Nanoscales, Fundamental concepts (Bottom-up and Top-down processes).		
Unit-2	**Application of Nanotechnology**	**(6 Hours)**
Application of Nanotechnology		
Unit-3	**Nanomaterials**	**(6 Hours)**
Fundamental concept of nanomaterial, Materials used in nanotechnology, carbon nanotubes-properties.		
Unit-4	**Synthesis of nano particles**	**(6 Hours)**
Synthesis, Purification, Application of Nanomaterials		
Unit-5	**Recent Advances in Nanotechnology**	**(6 Hours)**

Recent Advances in Nanotechnology		
Unit-6	**Intellectual property rights on Nanotechnology**	**(6 Hours)**
Importance of IP Protection, copy rights and trade secrets		
Learning Resources:		
Text Books **1)** Principles of Nanotechnology" , Phani umar		
Reference Books **2)** "The Nanoscope" Encyclopedia of Nanoscience and Nanotechnology Vol I to Vol 6, Edited by Dr.Parag Diwan and Ashish Bharadwaj		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE1042 Course Name: Green Technology

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:

Course Objectives: The objective of the course is to

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 Outcomes: After successful completion of the course, student will be able to

CO1	1. Understand the principles of green chemistry and engineering
CO2	2. Design processes those are benign and environmentally viable
CO3	3. Design processes and products those are safe and hazard free
CO4	4. Learn to modify processes and products to make them green safe and economically acceptable.
CO5	5. Apply the principles of green technology to specific industrial processes

Course Description:

Course Content

Unit-1	**Organic Chemistry**	**(6Hours)**
Introduction to Organic Chemistry /Analytical Chemistry /Basic Chemical Engineering		
Unit-2	**Introduction to Green Chemistry**	**(6Hours)**
Principles of Green Chemistry, Reasons for Green Chemistry (resource minimisation, waste minimization, co ncept s), Green reactions solvent free reactions, Catalyzed (heterogeneous / homogeneous) reactions, MW/ Ultrasound mediated reactions, Bio catalysts etc.		
Unit-3	**Introduction to Pharmaceutical Process Chemistry**	**(6 Hours)**
Introduction to process chemistry, the difference between synthesis and process.		
Unit-4	**Rote Design**	**(6 Hours)**
Rote design, Route optimization and DOE		
Unit-5	**Role of Analytical Chemistry**	**(6 Hours)**

Role of Analytical Chemistry in Process Chemistry Role of Process Safety in Process Chemistry: TH classification, MSDS, Thermal Hazards, Waste segregation and disposal.		
Unit-6	**Scale -up**	**(6 Hours)**
Scale-up aspects including PE in Process Chemistry: Case Studies; New Initiatives: Micro reactors.		
Learning Resources:		
Text 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)		
Reference Books **1)** Stanley E.Manahan, Green Chemistry and the Ten Commandments of Sustainability, 2nd ed (Paperback), ChemChar Research Inc (2005)		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE1043 Course Name: Pharmaceutical Biotechnology

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any: Knowledge of following subject is required

1. Mass Transfer
2. Engineering Chemistry

Course Objectives:

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 Outcomes: After successful completion of the course, student will be able to

CO1	1. Understand the various techniques used in modern biotechnology.
CO2	2. Design research strategy with step-by-step instructions to address a research problem
CO3	3. Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic
CO4	4. Demonstrate and Provide examples on how to use microbes and mammalian cells for the production of pharmaceutical products.
CO5	5. Explain the general principles of generating transgenic plants, animals and microbes

Course Description:

Course Content

Unit-1	**Drug Development**	**(6 Hours)**
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)		
Unit-2	**Techniques for new generation antibiotic**	**(6 Hours)**
Techniques for development of new generation antibiotics, Protein engineering, drug design, drug targeting.		
Unit-3	**Disease Diagnosis**	**(6 Hours)**

Disease Diagnosis and Therapy, ELISA and hybridoma technology,DNA vaccine, Gene Therapy, Toxicogenomics.		
Unit-4	**Drug Development**	**(6 Hours)**
Proteomics in Drug Development, Role of Proteomics in Drug Development		
Unit-5	**Proteomics**	**(6 Hours)**
Diagnosis of disease by Proteomics, Separation and identification techniques for protein analysis, Development of antibody-based protein assay for diagnosis.		
Unit-6	**Diagnosis and Kit Development**	**(6 Hours)**
Diagnosis and Kit Development, Use of enzymes in clinical diagnosis, Use of biosensors for rapid clinical analysis, Diagnostic kit development for microanalysis.		
Learning Resources:		
Text Books **1)** Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (ed), Concepts in Biotechnology, University Press, 1996		
Reference Books **1)** Epenetos A.A. (ed), Monoclonal antibodies: applications in clinical oncology, Chapman and Hall Medical, London		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE1051 Course Name: Bio Process Engineering

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any: Knowledge of following subject is required

1. Biochemical Engineering
2. Any biology subject

Course Objectives: The objective of the course is to

1) Apply engineering principles to address issues in bioprocesses
2) Analyze and identify limiting factors in a bioprocess
3) Explain the aerobic and anaerobic fermentation processes
4) Describe applications of 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 Outcomes: After successful completion of the course, student will be able to

CO1	Understanding of biological basics and bioprocessing
CO2	Understanding the difference between bioprocesses and chemical processes
CO3	Bioprocess design and operation
CO4	Choice of bioreactor
CO5	Heat & mass transfer considerations and scale up of bioprocesses
CO6	Introduction to bioprocess monitoring/control

Course Description:

Course Content

Unit-1	**Introduction**	**(6 Hours)**
Review of fundamentals of microbiology and biochemistry. Bioprocess principles: Kinetics of biomass production. Substrate utilization and product formation.		
Unit-2	**Fermentation**	**(6 Hours)**
Batch and continuous cultures. Fed batch culture introduction. Fermentation processes. General requirements of fermentation processes.		
Unit-3	**Fermentation Contd-**	**(6 Hours)**
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.		

Unit-4	**Enzyme technology**	**(6 Hours)**
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.		
Unit-5	**Mass transfer in heterogeneous biochemical reaction systems**	**(6 Hours)**
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.		
Unit-6	**Instrumentation and process control in bioprocesses**	**(6 Hours)**
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.		

Learning Resources:

Text Books

1) M. L. Shuler, F. Kargi. Bioprocess engineering. 2nd edition. PHI. New Delhi. 2002.

2) J. E. Bailey, D. F. Ollis. Biochemical engineering. 2nd edition. Mc Graw Hill Publication co.NY.1985.

Reference Books

1) Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, 2001

Tatyasaheb Kore Institute of Engineering and Technology First Year M. Tech Chemical Engineering Course Code: 2501PCHEPE1052 Course Name: Material Engineering		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any: Knowledge of following subject is required

1. Material Science

Course Objectives: The objective of the course is to

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 Outcomes: After successful completion of the course, student will be able to

Course Description:

Course Content

Unit-1	Engineering requirement of materials	(6 Hours)
Engineering requirement of materials, atomic bonding, atomic arrangements, structural imperfections and atom movements, electronic structures & process binary alloys and equilibrium diagrams.		
Unit-2	Metallic phases	(6Hours)
Metallic phases and their properties, phase transformations in iron carbon system		
Unit-3	Heat treatment	(6 Hours)

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.		
Unit-4	**Modification of properties**	**(6 Hours)**
Modification of properties through change in microstructure, corrosion, oxidation, thermal stability, radiation damage, composite materials		
Unit-5	**Crystallography**	**(6 Hours)**
Crystallography, X-Ray Diffraction Methods, Reitveld Refinement, Neutron Diffraction, X-ray absorption, XRay Fluorescence spectroscopy, Electron Diffraction- diffraction pattern in specific modes.		
Unit-6	**LEED and RHEED**	**(6Hours)**
LEED and RHEED, Electron Optics, Electron Microscopy-Transmission and Scanning Electron Microscopy, STM and AFM, Compositional analysis employing AES, ESCA and Electron Probe Microanalysis.		

Learning Resources:

Text Books

1) James F. Shackelford, Introduction to Materials Science for Engineers, 7th Edition, Pearson Prentice Hall(2009)
2) W. D. Callister, Fundamentals of Materials Science and Engineering, Wiley (2007)
3) C. Kittle, Introduction to Solid State Physics, Wiley (2007)

Reference Books

1) David D. Brandon and Wayne D. Kaplan Microstructural Characterization of Materials Wiley
2) Dawn Bonnel Scanning Probe Microscopy and Spectroscopy: Theory, Techniques, and Applications 2000.
3) C. Julian Chen Introduction to Scanning Tunneling Microscopy Monographs on the Physics and Chemistry of Materials

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE1053 Course Name: Process and Equipment Design

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any: Knowledge of following subjects

1. Chemical equipment design
2. Mass transfer
3. Heat transfer

Course Objectives: The objective of the course is to

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 have 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 Outcomes: After successful completion of the course, student will be able to

CO1	Recall their concepts in designing the chemical equipment's
CO2	Interpret causes of failure of chemical equipment
CO3	Have awareness on advances in process engineering design of many process equipment's
CO4	Take part in remedial or preventive measurements to avoid failure of vessel with safe design Guide lines
CO5	Evaluate and apply their ideas on dimensional analysis to explore the optimum design variables
CO6	Test the process equipment with prior safety.

Course Description:

The **Process and Equipment Design** course focuses on the systematic design of chemical processes and the mechanical design of major process equipment used in chemical industries. It integrates principles of thermodynamics, heat transfer, mass transfer, fluid mechanics, reaction engineering, and process control for the development of safe, economical, and efficient chemical plants.

Course Content

Unit-1	**Shell and Tube Heat exchanger**	**(6 Hours)**
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.		
Unit-2	**Heat Exchange equipment**	**(6 Hours)**

Plate Heat Exchanger, Bayonet Heat Exchanger, Heat Regenerator, Thermic Fluid Heating System Design Consideration.		
Unit-3	**Cooling tower**	**(6 Hours)**
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.		
Unit-4	**Reactor**	**(6 Hours)**
Reactor Classification, Design Equation for Batch PFR and CSTR, Fluidized Bed Reactor, Scale Up.		
Unit-5	**Separation Equipment**	**(6 Hours)**
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.		
Unit-6	**Pipe lines**	**(6 Hours)**
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.		

Learning Resources:

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 Books

1) Introduction to Process Engineering and Design 4th Reprint 2011, S. B. Thakore, B.I. Bhatt, Tata Mc-.Graw Hill, Education Pvt. Ltd, Delhi

MOOC / NPTEL/YouTube Links

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

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHELC106P Course Name: Advanced Separation Laboratory

Teaching Scheme	Credit	Evaluation Scheme
Practical: 04 Hours/Week	02	ISA: 25 Marks POE: 25 Marks

Prerequisites, if any:
Knowledge of following subject is required
1. Mass Transfer
2. Separation technique s

Course Objectives: The objective of the course is to
1. Learn new techniques of separation

2.. Learn possible cases of industrial application.

3. Learn estimation of separation coefficient

Course Outcomes: After successful completion of the course, student will be able to

CO1	Knowledge of recent advances in separation techniques.
CO2	Ability to separate different chemical compounds.
CO3	Ability to handle different advance equipment's.
CO4	Considerably more in-depth knowledge of the major subject.
CO5	Deeper knowledge of Experimental methods
CO6	Knowledge of industrial methods used for the separation processes.

Course Description:
The Advanced Separation Laboratory course provides practical exposure to advanced separation techniques widely used in chemical, petrochemical, biochemical, pharmaceutical, and environmental industries. The laboratory emphasizes the application of mass transfer principles to design, analyse, and optimize modern separation processes.

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Assigned Hours
1	Ultra filtration a) Pilot scale	(04)
2	Ultra filtration a) Small scale	(04)
3	Supported liquid membranes.	(04)
4	Microfiltration of raw material	(04)
5	Ion Exchange a) Resin	(04)

6	Ion Exchange b) Equilibria	(04)
7	Ion Exchange c) Column	(04)
8	Electro coagulation	(04)
9	Pressure swing Adsorption	(04)

Learning Resources:

Text Books

1) 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.

Reference Books

1) McCabe & Smith "Unit Operations of Chemical Engineering" 5th Ed.,McGraw Hill International.

2) Richardson and Coulson,“Chemical Engineering Volume –II”,Pergamon Press,1970.

3) Schweitzer P.A , “Handbook of Separation Techniques for Chemical Engineering” 2nd edn., McGraw Hill

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHESW107T Course Name: Seminar – I

Teaching Scheme	Credit	Evaluation Scheme
Practical: 02 Hours/Week	01	TW : 50 Marks

Prerequisites, if any:

Course Objectives: The objective of the course is to

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 Outcomes: After successful completion of the course, student will be able to

CO1	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.
CO2	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.
CO3	Think and create. Use multiple thinking strategies to examine real-world issues, explore creative avenues of expression, solve problems, and make consequential decisions
CO4	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.

Course Description:

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Assigned Hours

1	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.	**(-)**

SEMESTER-II

Tatyasaheb Kore Institute of Engineering and Technology First Year M. Tech Chemical Engineering Course Code: 2501PCHEPCC201 Course Name: Advanced Mass Transfer			
Teaching Scheme	Credit	Evaluation Scheme	
Lectures: 03 Hours/Week Tutorial 01 Hours/Week	04	ISE:	40 Marks
		ESE:	60 Marks
		ISA:	25 Marks

Prerequisites, if any:

Knowledge of following subjects

1. Mass transfer operation
2. Chemical process calculations

Course Objectives: The objective of the course is to

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 Outcomes: After successful completion of the course, student will be able to

CO1	Define various operations like distillation, extraction, leaching, Compare and classify various mass transfer operations with or without chemical reaction
CO2	Design calculation of distillation column for the multi-component system
CO3	Analyze the problem of Separation by adsorption and design of absorber, chromatographic separation
CO4	Evaluate the separation by liquid extraction, leaching used and justify the extract operation to choose for specific problem
CO5	Estimate final data for designing number of stages, Height of column in the operations
CO6	Define various operations like distillation, extraction, leaching

Course Description:

Course Content

Unit-1	Physical-Chemical Phenomena	(Assigned Hours)
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.		

Unit-2	**Mass transfer with Chemical reaction**	**(6 Hours)**
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.		
Unit-3	**Contacting devices**	**(6 Hours)**
Capacity and efficiency, energy requirements of separation process. Extractive distillation, Reactive distillation, cryogenic distillation and molecular distillation.		
Unit-4	**Multicompenent distillation**	**(6 Hours)**
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.		
Unit-5	**Adsorption, Ion exchange and chromatography**	**(6 Hours)**
Adsorption, equilibrium considerations, pure gas adsorption, liquid adsorption, Ion exchange equilibrium, equilibrium in chromatography, Kinetic and transport considerations, external and internal transport, mass transfer in ion exchange and chromatograph.		
Unit-6	**Extraction**	**(6 Hours)**
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.		

Learning Resources:

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” 6^{TH} 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” 3^{rd} 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

MOOC / NPTEL/YouTube Links

1. MOOCS/ Swayam/NPTEL Courses on Mass Transfer Operations I

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPCC202 Course Name: Chemical Process Control

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week Tutorial: 01 Hours/Week	04	ISE: 40 Marks ESE: 60 Marks
		ISA: 25 Marks

Prerequisites, if any:
Knowledge of following subjects
Mass transfer, Chemical reaction engineering

Course Objectives: The objective of the course is to
1. To understand the need for process control in chemical industries and the dynamic behavior of process systems.
2. To develop mathematical models for first-order, second-order, and higher-order process systems

Course Outcomes: After successful completion of the course, student will be able to

CO1	Develop structured, logical control schemes for complex processes
CO2	Study dynamics of process and control behavior.
CO3	Choose control configurations for standard operations.
CO4	Estimate controller parameter setting
CO5	Understand type of controller that can be used for specific problem in chemical industry.
CO6	Design digital control systems

Course Description:
This course focuses on the analysis and control of dynamic behaviour in chemical process systems. It introduces the fundamental concepts of process dynamics, mathematical modelling, and control system design necessary for maintaining process variables such as temperature, pressure, flow, and composition within desired limits.

Course Content

Unit-1	**Introduction To Feed Back Control**	**(6 Hours)**

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.

Unit-2	**Mass Transfer with Chemical Reactions**	**(6 Hours)**

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

Unit-3	Frequency Response Analysis Of Linear Process	(6 Hours)
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.		
Unit-4	**Feed Back Control of System with Large Dead Time or Inverse Response**	**(6 Hours)**
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.		
Unit-5	**Feed Forward and Ratio Control:**	**(6 Hours)**
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.		
Unit-6	**Plant Wide Control System Design**	**(6 Hours)**
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.		

Learning Resources:

Text 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

Reference Books

1. Process Control Modeling, Design And Simulation, B.Wayne Beqnette, Prentice Hall Of India, New Delhi2004

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE2031 Course Name: Modern Reaction Engineering

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:
Knowledge of following subject is required
1. Chemical reaction Engineering

Course Objectives: The objective of the course is to
1. To understand the principles of designing reactors
2. To evaluate reaction rates in different types of reactors
3. To understand the design and operation of catalytic reactors
4. To design and modify rectors to make processes safe and efficient
5. Analyze multiple reactions carried out both isothermally and non-isothermally in flow, batch and semi batch reactors to determine selectivity and yield.
6. Describe the steps in a catalytic mechanism and how one goes about deriving a rate law,
7. mechanism, and rate- limiting step that are consistent with experimental data.

Course Outcomes: After successful completion of the course, student will be able to

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 Description:
The Modern Reaction Engineering course provides an advanced understanding of chemical reaction kinetics and reactor design with emphasis on contemporary industrial applications. The course integrates fundamental reaction engineering principles with modern analytical, computational, and optimization techniques used in the design and operation of chemical reactors.

Course Content

Unit-1	**Introduction**	**(6Hours)**
A brief review of Chemical kinetics and Ideal reactor		
Unit-2	**Non-Ideal flow and mixing**	**(6 Hours)**
Mixing concept, RTD, Response measurement, segregated flow model, Dispersion model, Tank in Series model, recycle rector model, analysis non ideal reactor		

Unit-3	Heterogeneous reaction	(6 Hours)
Classification, Rate Controlling step, globale rate of eaction.		
Unit-4	Fluid-solid Non-Catalytic reaction	(6 Hours)
Sinking core model, untreated core model, kinetics of non-catalytic reaction for spherical and cylindrical solid particles, Contacting patterns, Reactor design.		
Unit-5	Fluid-Fluid Reaction	(6 Hours)
Gas-liquid reaction, practical ability of film theory, kinetic regime identification, kinetics of fluid-fluid reaction, Contacting patterns, Reactor design.		
Unit-6	Catalysis and Catalytic reaction	(6 Hours)
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.		

Learning Resources:

Text Books

1. Octave Levanspeil, Chemicaal Reaction Engineering, Jhon Wiley, London
2. S.M.Walas,ReactionKineticsforChemicalEngineers,McGrawHill,NewYark

Reference Books

1. J. M. Smith, Chemical Reaction Kinetics, Mc GrawHill,1981
2. Bischott and Froment, Chemical Reactor Designandanalysis,Wesley-1982

Tatyasaheb Kore Institute of Engineering and Technology First Year M. Tech Chemical Engineering				
Course Code: 2501PCHEPE2032 Course Name: Catalysis and Surface Phenomena				
Teaching Scheme		Credit	Evaluation Scheme	
Lectures:	03 Hours/Week	03	ISE:	40 Marks
			ESE:	60 Marks

Prerequisites, if any: Knowledge of following subject

1. Chemical Reaction Engineering

Course Objectives: The objective of the course is to

1. To understand the fundamental principles of surface chemistry including adsorption, surface energy, and interfacial phenomena.
2. To explain the mechanisms of heterogeneous, homogeneous, and enzymatic catalysis and their industrial significance.

Course Outcomes: After successful completion of the course, student will be able to

CO1	To understand the concepts of homogenous and heterogeneous catalysis, catalytic activity and selectivity
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.

Course Description:

Course Content

Unit-1	**Introduction of Catalysis**	**(6 Hours)**
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.		
Unit-2	**Catalysts Characterization**	**(6 Hours)**
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.		
Unit-3	**Theories of Catalysts**	**(6 Hours)**
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.		

Unit-4	Mass and Heat Transport in Porous Catalysts	(6 Hours)
Internal and external transport, fixed bed, Fluidized bed reactors, Effect of internal transport on selectivity. Effectiveness factor and Thiele modulus.		
Unit-5	**Catalyst Deactivation**	**(6 Hours)**
Poisons, sintering of catalysts, Pore mouth plugging and uniform poisoning models, Kinetics of deactivation, Catalyst regeneration.		
Unit-6	**Industrial Catalysis**	**(6 Hours)**
Industrial catalysts preparation methods, Typical industrial catalytic processes, Case studies, Catalytic deactivation prevention methods, new techniques for catalyst characterization, Overall study.		
Learning Resources:		
Text 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.		
Reference Books 1. Thomas and Thomas - "Introduction to Heterogeneous Catalysts ", Academic Press, London 1967		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE2033 Course Name: Down Stream Processing

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:
Mass transfer Fluid
Mechanics

Course Objectives: The objective of the course is to

1. **To understand the importance of downstream processing** in biochemical, pharmaceutical, and bioprocess industries for product recovery and purification.
2. **To study the various stages of downstream processing**, including removal of insolubles, product isolation, purification, and polishing.

Course Outcomes: After successful completion of the course, student will be able to

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.

Course Description:

Course Content

Unit-1	Requirement of Downstream Processing	(6 Hours)

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.

Unit-2	Biomass Removal and Disruption	(6 Hours)

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

Unit-3	Biomass Removal and Disruption	(6 Hours)

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.

Unit-4	Membrane Based Separation	(6 Hours)
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.		
Unit-5	**Separation by Adsorption and Chromatography**	**(6 Hours)**
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.		
Unit-6	**Case Studies**	**(6 Hours)**
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.		
Learning Resources:		

Text 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 Inter science Publication,1988.

Reference Books

1) J. E. Baileyand D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc.,1986
2) Separation, Recovery and Purification in Biotechnology, Aenjo J. A.and J. Hong
3) Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamonpress (1984)

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering
Course Code: 2501PCHEPE2041 Course Name: Computational Fluid Dynamics

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any: Fluid Mechanics Mass Transfer

Course Objectives: The objective of the course is to
1. **To understand the fundamental governing equations of fluid flow and heat transfer**, including continuity, momentum (Navier–Stokes), and energy equations.
2. **To develop knowledge of numerical methods** such as finite difference, finite volume, and finite element methods used in CFD.

Course Outcomes: After successful completion of the course, student will be able to

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	Define and setup flow problem properly within CFD context, performing solid modelling and producing grids via meshing tool
CO3	Understand solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly
CO4	Develop an awareness of the power and limitations of CFD
CO5	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 Description:

Course Content

Unit-1	**Governing Differential Equation And Finite Difference Method**	**(6 Hours)**
Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference.		
Unit-2	**Uniform and non-uniform Grids**	**(6 Hours)**
Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.		
Unit-3	**Conduction Heat Transfer**	**(6 Hours)**
Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.		
Unit-4	**Incompressible Fluid Flow**	**(6 Hours)**
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.		
Unit-5	**Convection Heat Transfer and Fem**	**(6 Hours)**

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.

Unit-6	Algebraic Models	(6 Hours)

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.

Learning Resources:

Text 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) Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag,1987.

Reference Books

1) Bose, T. X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE2042 Course Name: Energy Engineering

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:

Students should have learnt following subjects

1. Heat transfer
2. Fluid mechanics
3. Mass transfer

Course Objectives: The objective of the course is to

1) To understand various conventional and non-conventional energy resources and their role in sustainable development.

2) To explain the principles of energy conversion systems including thermal, electrical, and renewable energy technologies.

Course Outcomes: After successful completion of the course, student will be able to

CO1	CO1: Discuss and compare various types of energy resources and the principles for converting from one form to another.
CO2	CO2: Analyse and evaluate energy use over the lifecycle of a product or project.
CO3	CO3: Collect data from thermodynamic systems and evaluate the performance of the system.
CO4	CO4: Evaluate the global considerations of energy production, management and conservation including the environmental and economic impact of common fuels.
CO5	CO5: Understanding Energy management methods. Rational energy consumption. Energy conservation. Waste heat recovery.

Course Description:

Course Content

Unit-1	**Energy**	**(6 Hours)**

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).

Unit-2	**Nuclear Reactors**	**(6 Hours)**

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.		
Unit-3	**Solar Energy**	**(6 Hours)**
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.		
Unit-4	**Rotor**	**(6 Hours)**
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.		
Unit-5	**Biomass Energy**	**(6 Hours)**
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.		
Unit-6	**Energy conservation**	**(6 Hours)**
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.		

Learning Resources:

Text Books

1. Power Plant Engineering, P. K. Nag Tata McGraw Hill 2nd edn2001.
2. Power Plant Engineering, Domakundawar, Dhanpath Rai sons.2003

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. Rai G.D.,Non-ConventionalEnergySources,KhannaPub.

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEPE2043 Course Name: Advanced Separation Techniques

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:
Any subject of chemical Engineering

Course Objectives: The objective of the course is to

1) To understand the principles of advanced separation processes used in chemical, petrochemical, biochemical, and environmental industries.
2) To analyse mass transfer mechanisms and thermodynamic principles governing separation operations.

Course Outcomes: After successful completion of the course, student will be able to

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 Description:

Course Content

Unit-1	**Introduction**	**(6 Hours)**
General Review of Conventional process, recent advances in separation technique based on size, surface properties ionic properties and other special characteristics of substance.		
Unit-2	**Filtration**	**(6 Hours)**
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.		
Unit-3	**Membrane filtration**	**(6 Hours)**
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.		
Unit-4	**Separation by Adsorption technique**	**(6 Hours)**

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.		
Unit-5	**Ionic Separation**	**(6 Hours)**
Controlling factor, application, type of equipment used in electrophoresis, dielectrophoresis, ion exchange chromatography, and electro- dialysis, commercial processes.		
Unit-6	**Other technique**	**(6 Hours)**
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.		
Learning Resources:		
Text books **1)** LaceyR.E andS.loaeb,industrial processing with membrane,wiely, newyark-1972 **2)** King C. J, Separationprocesses,TataMc-Graw–hillpublicationCo.ltd-1982		
Reference Books **1)** Schoew, HM, New Chemical Engineering Separation technique, future sciencepublisher 1972 **2)** Ronald W.Ronssel,Hand book of process Technology, wilynewYork 1998		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEOE2051 Course Name: Project Management

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:
Knowledge of any engineering branch

Course Objectives: The objective of the course is to

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 behavior
5) To study and develop a project scope
6) Ability to use CPM and PERT methods

Course Outcomes: After successful completion of the course, student will be able to

CO1	Define various operations like distillation, extraction, leaching, Compare and classify various mass transfer operations with or without chemical reaction
CO2	Design calculation of distillation column for the multi-component system
CO3	Analyze the problem of Separation by adsorption and design of absorber, chromatographic separation
CO4	Evaluate the separation by liquid extraction, leaching used and justify the extract operation to choose for specific problem
CO5	Estimate final data for designing number of stages, Height of column in the operations
CO6	Define various operations like distillation, extraction, leaching

Course Description:
This course introduces the fundamental principles and practices of project management as applied to engineering projects. It covers the complete project life cycle from project initiation, planning, scheduling, execution, monitoring, and control to project closure. Emphasis is placed on managing engineering projects involving technical complexity, cost constraints, time limitations, and quality requirements.

Course Content

Unit-1	Project Management growth	(6 Hours)
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		

Unit-2	**Organizational structure**	**(6 Hours)**
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)		
Unit-3	**Organizing and staffing the project office and team**	**(6Hours)**
The staffing environment, Selecting the project manager, Skill requirement for project and programme manager, Organizational staffing progress, The project office, Project organizational chart		
Unit-4	**Management function**	**(6 Hours)**
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		
Unit-5	**Special Topic**	**(6 Hours)**
Performance measurement, Financial compensation and rewards, Critical Issues with rewarding project team, mega Project, Morality, Ethics and corporate culture.		
Unit-6	**Special Topic -Cont**	**(6Hours)**
Professional Responsibility, Internal Prternership , External Prternership, Training and education, Integrated project steam, Virtual project team, Break through		
Learning Resources:		
Text Books **1)** 1. "A system Approachto planning, Scheduling, Controlling, by Harolad Kerzner 10th Ed Willy		
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 and Technology First Year M. Tech Chemical Engineering Course Code: 2501PCHEOE2052 Course Name: Operations Research		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:

Course Objectives: The objective of the course is to

Course Outcomes: After successful completion of the course, student will be able to

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	Define and formulate linear programming problems and appreciate their limitations
CO6	CO5: Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.

Course Description:

Course Content

Unit-1	**Introduction to Operations Research:**	**(6 Hours)**
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		
Unit-2	**Transportation**	**(6 Hours)**
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.		
Unit-3	**Assignment model.**	**(6 Hours)**

Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem.		
Unit-4	**Sequencing models**	**(6 Hours)**
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.		
Unit-5	**Dynamic programming**	**(6 Hours)**
. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.		
Unit-6	**Games Theory.**	**(6 Hours)**
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		
Learning Resources:		
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.		

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHEOE2053 Course Name: Energy Technology

Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

Prerequisites, if any:
Knowledge of following subject is required
1. Energy engineering

Course Objectives: The objective of the course is to

1. To understand various conventional and non-conventional energy resources and their role in sustainable development.
2. To explain the principles of energy conversion systems including thermal, electrical, and renewable energy technologies.

Course Outcomes: After successful completion of the course, student will be able to

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 Description:
Energy Technology provides a comprehensive understanding of conventional and renewable energy resources, energy conversion systems, and sustainable energy management practices. The course focuses on the principles, technologies, and performance analysis of various energy generation and utilization systems used in modern engineering applications.

Course Content

Unit-1	**Introduction**	**(6Hours)**
Classification of energy resources: renewable vs. non-renewable, Global & Indian energy scenario, Energy demand and supply projections, Environmental impact of energy use.		
Unit-2	**Conventional Energy Conversion Systems**	**(6Hours)**
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		
Unit-3	**Solar Energy Technology**	**(6Hours)**
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.		
Unit-4	**Wind, Biomass & Other Renewables**	**(6Hours)**
Wind Energy: principles, wind turbines, site selection, wind farms. Biomass: resources, combustion, gasification, digestion, biofuels. Other Sources: tidal, wave, geothermal, ocean thermal, small hydro.		
Unit-5	**Energy Storage & Emerging Technologies**	**(6Hours)**
Electrical storage: batteries, supercapacitors. Mechanical storage: flywheels, pumped hydrogen, compressed air. Hydrogen energy & fuel cells. energy systems and smart grids.		
Unit-6	**Energy Management, Audit & Policy**	**(6Hours)**
Energy conservation principles and practices. Energy efficiency in industries and buildings. Energy audit – methods and instrumentation, National energy policies, renewable energy programs in India.		
Learning Resources:		
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 and Technology First Year M. Tech Chemical Engineering		
Course Code: 2501PCHELC206T Course Name: Analytical Laboratory		
Teaching Scheme	Credit	Evaluation Scheme
Practical: 02 Hours/Week	01	ISA: 25 Marks

Course Objectives: The objective of the course is to

1. **To understand** the principles and working of common analytical instruments used in chemical engineering laboratories.
2. **To develop skills** in quantitative and qualitative chemical analysis using classical and instrumental techniques.

Course Outcomes: After successful completion of the course, student will be able to

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 Description:

This course provides hands-on training in classical and instrumental analytical techniques used in chemical engineering practice. The laboratory focuses on quantitative and qualitative analysis of chemical substances relevant to process industries, environmental monitoring, and quality control.

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Assigned Hours
1	Analysis Of Given Sample by using Gas Chromatography	**2**
2	Detail study and Analysis of High-Performance Liquid Chromatography (HPLC)	**2**
3	Instrument Exploration: Scanning Electron Microscopy (SEM)	**2**
4	Measurement, analyze, and discussion of three different types of Samplevia Thermo gravimetric Analysis, or TGA	**2**
5	Determination of the amount of carbon monoxide in exhaust samples by FTIR spectroscopy	**2**
6	Spectrophotometry: Absorption spectra and the use of light absorption to measure concentration	**2**

7	Analysis by using Gel Electrophoresis	**2**

Learning Resources:

Text Books

1) Instrumental Methods of Chemical Analysis" — *B. K. Sharma*

Tatyasaheb Kore Institute of Engineering and Technology First Year M. Tech Chemical Engineering		
Course Code: 2501PCHESW207T Course Name: Seminar – II		
Teaching Scheme	Credit	Evaluation Scheme
Practical: 02 Hours/Week	01	ISA: 50 Marks

Course Objectives: The objective of the course is to

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 Outcomes: After successful completion of the course, student will be able to

CO1	Apply principles of ethical leadership, collaborative engagement, socially responsible behaviour, respect for diversity in an interdependent world, and a service-oriented commitment to advance and sustain local and global communities.
CO2	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.
CO3	Think and create. Use multiple thinking strategies to examine real-world issues, explore creative avenues of expression, solve problems, and make consequential decisions
CO4	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.

Course Content

Sr. No.	Seminar II	Assigned 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.	

Tatyasaheb Kore Institute of Engineering and Technology
First Year M. Tech Chemical Engineering

Course Code: 2501PCHECV208P Course Name: Comprehensive Viva

Teaching Scheme	Credit	Evaluation Scheme
Practical: 02 Hours/Week	01	ESE oral : 25 Marks

Course Objectives: The objective of the course is to

1. To verify the continuous assessment and performance of students by external examiner and internal examiner

Course Outcomes: After successful completion of the course, student will be able to

CO1	Verify their knowledge based on the subjects they have studied in Semester-I and Semester-II

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Assigned Hours
1	The students have to prepare on all subjects which they have studied in Ist and IInd semesters The viva will be conducted by the External/Internal Examiner jointly and their appointments will be made by institute. The in-depth knowledge, preparation and subjects understanding will be assessed by the Examiners.	**(--)**