Dr. Babasaheb Ambedkar Technological University, Lonere

(Established as a University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
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Curriculum for

Undergraduate Degree Programme

B. Tech. Third Year Petrochemical

In line with National Education Policy 2020

With effect from AY 2025-2026

Department of Petrochemical Engineering

Credit Framework under Four-Years UG Engineering Programme with Multiple Entry and Multiple Exit options:

- The Four-year Bachelor's Multidisciplinary Engineering Degree Programme allows the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning from different institutions.
- The minimum and maximum credit structure for different levels under the Four-year Bachelor's Multidisciplinary Engineering UG Programme with multiple entry and multiple exit options are as given below:

Credit Framework

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	One Year UG Certificate in Engg./ Tech.	40	44	2	1
5.0	Two Years UG Diploma in Engg./ Tech.	80	88	4	2
5.5	Three Years Bachelor's Degree in Vocation (B. Voc.) or B. Sc. (Engg./ Tech.)	120	132	6	3
	4-Years Bachelor's degree				

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	(B.E./ B.Tech. or Equivalent) in Engg./ Tech. with Multidisciplinary Minor	160	176	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors with Research and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Major Engg. Discipline with Double Minors (Multidisciplinary and Specialization Minors)	180	194	8	4

- There are multiple exit options at each level. Student will be given a specific Qualification mentioned in the table depending on the level at which he/she decides to have an exit. Ex. If a student decides to exit after completion of two years (level 5.0) of the program, he will be given a Diploma in Engineering with specific exit condition mentioned in the syllabus of the specific branch. He/she can re-join the program with the multiple entry option at the level next where he/she chose to exit previously. (Student can join at level 5.5 if successfully completed level 5.0 previously at the time of exit).
- Minimum credit requirements of each level are mentioned in the credit framework table.
  - There are 4 distinct options available at level 6.0.

- First one is basic level 6.0 option where minimum 160-maximum 176 credits are mandatory which can be completed as per the Semester-wise Credit distribution structure mentioned in the table given below.

Here, the Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with multidisciplinary minor (min.160-max.176 Credits) i.e. "**B. Tech. in Petrochemical Engineering with Computer Engineering**" (160 - 176 credits) enables students to take up four - six or required additional courses of 14 credits in the discipline other than Petrochemical Engineering distributed over semesters III to VIII. Here in the case of "**B. Tech. in Petrochemical Engineering with Computer Engineering**" (160 - 176 credits) student is supposed to take up courses to complete the credits (assigned 14 credits) from **Computer Engineering minor bucket**.

- Remaining three level 6.0 options are the advanced options where the student is given an opportunity to get extra qualification by earning some extra credits (18-20 extra credits). These three options are given below:
- Level 6.0: The **Bachelor's Engineering Degree with Honors** in chosen Major Engg./ Tech. Discipline i.e. in Petrochemical Engineering with Honours with Multidisciplinary Minor (180 - 194 credits) enables students of Petrochemical Engineering to take up four - six additional courses of 18 to 20 credits in the Petrochemical Engineering discipline distributed over semesters III to VIII. The decision regarding the mechanism of distribution of these 18 - 20 credits over semesters III to VIII, which are over and above the min.160 - max.176 Credits prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree with Research** in i.e. in Petrochemical Engineering with Research with Multidisciplinary Minor (180-194 credits) enables students of Petrochemical Engineering to take up a research project of 18 to 20 credits in the Petrochemical Engineering discipline distributed over semesters VII to VIII. **Student must have CGPA equal to or greater than 7.5 at the end of sixth semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with Double Minor** (Multidisciplinary and Specialization Minor, 180-194 credits), i.e. "**B. Tech in Petrochemical Engineering with *other selected discipline in* Engineering (as MDM) with Specialization Minor in Computer Engineering**" (180-194 credits) enables students to take up four - six additional courses of 14 credits in the discipline other than Petrochemical Engineering(for completion of multidisciplinary minor) and 18 to 20 extra credits in the **Computer Engineering discipline** distributed over semesters III to VIII. Here, the ***other selected discipline* in Engineering should be different from Specialization Minor i.e. Computer Engineering**. This enables students to take up four - six or required additional courses of 18 to 20 credits in the **Computer Engineering** discipline distributed over semesters III to VIII, which are over and above the min.160 - max.176 credits. The decision regarding the mechanism of distribution of these 18-20 credits over semesters III to VIII, prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.

Semester-wise Credit distribution structure for Four Year UG Engineering Program - One Major, One Minor

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	06-08	08-10		--	--	--	--	--	14-18
Engineering Science Course		10-08	06-04		--	--	--	--	--	16-12
Programme Core Course (PCC)	Program Courses	--	02	08-10	08-10	10-12	08-10	04-06	04-06	44-56
Programme Elective Course (PEC)		--	--	--	--	04	08	02	06	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses		-	02	02	04	02	02	02	14
Open Elective (OE) Other than a particular program		--	--	04	02	02	--	--	--	08
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	--	02	--	02	--	--	08
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	02	--	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)			02		--	--	--	--	--	02
Value Education Course (VEC)		--	--	02	02	--	--	--	--	04
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--		04	04
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	02	--	--	--	-	-	02
Project		--	--	--	--	--	--		04	04
Internship/ OJT		--	---			--	--	12	-	12
Co-curricular Courses (CC)	Liberal Learning Courses	02	02		--	--	--	--	-	04
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

Student need to follow the Semester-wise Credit distribution structure for Four Year UG Engineering Program as prescribed in the table given above.

- There are seven vertical categories with specific credits distributed in specific semesters.
- Student can choose a Program Elective Course (PEC) in that specific semester from the given subjects.
- Multidisciplinary course (MDM) and Open Elective (OE) courses can be chosen from the MDM and OE Buckets depending on student's choice. Completion of total credits given in the last column of the table for each vertical is mandatory.
- Students can complete 40% of the courses through online platforms like NPTEL/SWAYAM. The NPTEL SWAYAM course content should be at least 80% similar to the course content in the syllabus.

General Rules and Regulations

1. The normal duration of the course leading to B. Tech. degree will be EIGHT semesters.

2. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session/Semester as well. For 1st year B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.

3. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.

4. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

Registration:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full- Time Student of a UG/PG Programme:

   A full-time student of a particular UG/PG programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PG programme as stipulated in the specific Regulations pertaining to that UG/PG programme.

2. Mandatory Pre-Registration for higher semesters: In order to facilitate proper planning of the academic activities of a semester, it is essential for every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.

3. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.

2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.

3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.

4. A student will be permitted to register in the next semester only if he fulfils the following conditions:

i) Satisfied all the Academic Requirements to continue with the programme of Studies without termination

ii) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;

iii) Paid all required advance payments of the Institute and hostel for the current semester;

iv) Not been debarred from registering on any specific ground by the Institute.

Evaluation System:

1. Absolute grading system based on absolute marks as indicated below will be implemented from academic year 2023-2024, from I year B. Tech.

Percentage of marks	Letter Grade	Grade Point
91-100	EX	10.0
86-90	AA	9.0
81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5
40-50	EE	5.0
<40	EF	0.0

2. Class is awarded based on CGPA of all eighth semester of B.Tech. Program.

Award of Class:

The candidates who successfully complete all course/curriculum requirements of B.Tech Programme shall be awarded class as specified below:

a) Those who score CGPA of 8.25 and above shall be awarded First Class with Distinction.
b) Those who score CGPA of 6.75 and above but below 8.25 shall be awarded First Class.
c) Those who score CGPA below 6.75 shall be awarded Second Class.

Following will be the equivalent percentage of CGPA on Ten Point Scale:
The formula used to convert CGPA to percentage is

Percentage of Marks = (CGPA – 0.75) * 10.

Cumulative Grade Point Average (CGPA)	**Equivalent Percentage of Marks**
5.75	**50**
6.25	**55**
6.75	**60**
7.25	**65**
7.75	**70**
8.25	**75**

3. A total of 100 Marks for each theory course are distributed as follows:

Mid Semester Exam (MSE) Marks	20
Continuous Assessment Marks	20
End Semester Examination(ESE)Marks	60

4. A total of 100 Marks for each practical course are distributed as follows

1.	Continuous Assessment Marks	60
2.	End Semester Examination (ESE)Marks	40

- It is mandatory for every student of B. Tech to score a minimum of 40 marks out of 100, M. Tech to score a minimum of 45 marks out of 100 with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.
- This will be implemented from the first year of B. Tech starting from Academic Year 2023-24

5. Description of Grades

EX Grade: An 'EX' grade stands for outstanding achievement.

EE Grade: The 'EE' grade stands for minimum passing grade.

The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only.

If any of the students remain absent for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.

FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance. The students who have been awarded 'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance

a. Semester Grade Point Average (SGPA)

The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{[\sum_{i=1}^{n} c_i g_i]}{[\sum_{i=1}^{n} c_i]}$$

Where,
'n' is the number of subjects for the semester,
'c_i' is the number of credits allotted to a particular subject, and
'g_i' is the grade-points awarded to the student for the subject based on his performance as per the above table.
SGPA will be rounded off to the second place of decimal and recorded as such.

b. Cumulative Grade Point Average (CGPA):

An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (upto two decimal places).Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{[\sum_{i=1}^{m} c_i g_i]}{[\sum_{i=1}^{m} c_i]}$$

Where,

'm' is the total number of subjects from the first semester onwards up to and including the semester S,

'ci' is the number of credits allotted to a particular subject, and

'gi' is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

CGPA will be rounded off to the second place of decimal and recorded as such.

7. Attendance Requirements:

a. All students must attend every lecture, tutorial and practical classes.

b. To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted. If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination. The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be. In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

c. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.

d. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

8. Transfer of Credits:

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a. 20 % of the total credit will be considered for respective calculations.

b. Credits transferred will be considered for overall credits requirements of the

programme.

c. Credits transfer can be considered only for the course at same level i.e UG, PG etc.

d. A student must provide all details (original or attested authentic copies) such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.

e. A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.

f. Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.

g. In exceptional cases, the students may opt for higher credits than the prescribed

SEMESTER – V

Sr. No.	Course Code	Subject Title	Contact Hours			Credits	Category
			L	T	P		
1.	25UD1527PC501	Chemical Engineering Thermodynamics – II	3	-	-	3	PCC
2.	25UD1527PC502	Mass Transfer Operations – I	3	-	-	3	PCC
3.	25UD1527PC503	Chemical Reaction Engineering- I	3	-		3	PCC
4.	25UD1527PC504	Petrochemical Technology	3			3	PCC
5.	25UD1MACOEM05K	Open Elective III A) Corporate Communication B) Basic Principles of Finance and Economy C) Waste to Energy	3	-	-	3	OE
6.	25UD1527MD506	MDM III (Petroleum Products –I)	3	-	-	3	MDM
7.	25UD1527PE507	PEC- I A) Numerical Methods and Computer Programming B) Introduction to Catalysis C) Materials for Engineering Applications	2			2	PEC
8.	25UD1527PCL508	Chemical Engg. - I Laboratory	-	-	2	1	PCC
9.	25UD1527PCL509	Petroleum Engineering - II Laboratory	-		2	1	PCC
10.	25UD1527MP510	Mini Project - I	-	-	2	1	PCC
		Total	**20**	**-**	**6**	**23**	

*** Refer to Open Elective Bucket**

**** Refer to Multidisciplinary Minor Bucket**

Open Elective III

A) Corporate Communication

B) Basic Principles of Finance and Economy

C) Waste to Energy

SEMESTER – VI

Sr. No.	Course Code	Subject Title	Contact Hours			Credits	Category
			L	T	P		
1	25UD1527PC601	Chemical Reaction Engineering – II	3	-	-	3	PCC
2	25UD1527PC602	Process Instrumentation and Control	3	-	-	3	PCC
3	25UD1527PC603	Mass Transfer Operations – II	3	-	-	3	PCC
4	25UD1527PC604	Petroleum Engineering – II	3	-	-	3	PCC
5	25UD1527PE605	PEC II A) Energy Management in Petrochemical Industry B) Catalytic Processes in Petrochemical Industry C) Introduction to Nanotechnology	3	-	-	3	PEC
	25UD1527MD606	MDM IV (Petroleum Products –II)	3	-	-	3	MDM
6	25UD1527PE607	PEC III A) Heat Transfer Equipment Design B) Fertilizer Technology C) Pharmaceutical and Fine Chemicals	3	-	-	3	PEC
7	25UD1527PCL608	Chemical Engg. – II Laboratory	-	-	2	1	VSEC
8	25UD1527PCL609	Process Instrumentation and Control Laboratory	-	-	2	1	PCC
9	25UD1527JC610	Journal club	-	-	2	1	PCC
10		Field Training/ Internship 3/Industrial Training (minimum of 4 weeks which can be completed partially in fifth semester and sixth semester or in at one time)					Internship
		Total	**21**	**-**	**6**	**24**	

**** Refer to Multidisciplinary Minor Bucket**

Semester – V

Chemical Engineering Thermodynamics – II **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PC501	Chemical Engineering Thermodynamics – II	3	-	-	20	20	60	100	03

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Calculate heat effects involved in industrial chemical processes
CO2: Determine thermodynamic properties of gaseous mixtures / solutions
CO3: Calculate Bubble-P & T, Dew-P & T for binary and multi-component systems
CO4: Calculate vapour-liquid equilibrium (VLE) composition for ideal and non-ideal systems
CO5: Determine equilibrium constant and composition of product mixture at given temperature and pressure

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	✓	✓	-	-	-	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed Syllabus:

Unit I
Vapour/Liquid Equilibrium Introduction: The nature of equilibrium, the Phase Rule, Duhem's Theorem, VLE: Qualitative behaviour, Simple models for vapour/liquid equilibrium, VLE by modified Raoult's Law, VLE from K- value correlations.

Unit II
Solution Thermodynamics Theory: Fundamental property relation, The chemical potential and phase equilibria, Partial properties, Ideal gas mixtures.
Fugacity and fugacity coefficient: Species in the solution, generalized correlations for the fugacity coefficient, The ideal solution, Excess properties.

Unit III
Solution Thermodynamics Applications: Liquid-phase properties from VLE data, Models for the excess Gibbs energy, Property changes of mixing, Heat Effects of mixing processes.

Unit IV
Chemical Reaction Equilibria: The reaction coordinate, Application of equilibrium criteria to chemical reactions, The standard Gibbs energy change and equilibrium constant, Effect of temperature on the equilibrium constants.

Unit V
Chemical Reaction Equilibria: Relation of equilibrium constants to composition, Equilibrium conversions for single reactions, Phase rule and Duhem's theorem for reacting systems, Multi reaction equilibria, Fuel cells

Text/Reference books:

1. J. M. Smith, H.C. Van Ness, and M. M. Abbott, Chemical Engineering Thermodynamics, 6thed, Tata McGraw Hill edition, 2003.
2. Y. V. C. Rao, "Chemical Engineering Thermodynamics", University Press 1997
3. S. I. Sandler. "Chemical Engineering

Mass Transfer Operations – I **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PC502	Mass Transfer Operations – I	3	-	-	20	20	60	100	03

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand Fick's law of diffusion
CO2: Determine diffusivity coefficient in gases and liquids
CO3: Determine mass transfer coefficients
CO4: Calculate rate of mass transfer in humidification
CO5: Select equipment for gas-liquid operations

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	-	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	-	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed syllabus:

Unit I

Diffusion in Fluids: Fick's Law of diffusion equimolecular counter diffusion, diffusion in stationary gas. Maxwell's law of diffusion. Inter phase mass transfer - Mass transfer equilibrium, diffusion between two phases. Local mass transfer coefficient, Local and average overall mass transfer coefficients. Simultaneous heat and mass transfer.

Unit II

Material Balance and Gas Absorption: Steady state co current and counter current processes stage wise and differential contacts. Number of theoretical stages.Stage efficiency HTU.Equilibrium solubility of gases.Material balance for transfer of one component. Counter current, multistage operations for binary and multi component systems. Continuous contactors

Unit III

Absorption and Gas Liquid Operation Equipment: Absorption with chemical reaction, Sparged vessels (bubble columns), mechanically agitated vessels for a single phase and gas liquid contact. liquid dispersed scrubbers, venturi scrubbers, wetted towers packed towers. Mass transfer coefficients for packed towers co-current flow of gas and liquid.

Unit IV

Liquid–Liquid Extraction: Calculations with and without reflux for immiscible and partially miscible system.

Leaching: Leaching single and multistage operations based on solvent free co-ordinates.

Unit V

Adsorption and Ion-exchange: Types of adsorption, Nature of adsorption, Freundlich equation, Stage wise and continuous adsorption. Theory of ion – exchange and its application to removal of ionic impurity.

Texts / References:

1. R. E. Treybal, Mass transfer operations, 3ed ed. McGraw Hill, 1980. A. S. Foust et al. Principles of Unit Operations
2. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 ELBS, Pergaman press, 1970
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergaman press, 1970

Chemical Reaction Engineering - I **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PC503	Chemical Reaction Engineering- I	3	-	-	20	20	60	100	03

Course Outcomes:

At the end of the course, students will be able to:

CO1: Compare the performance of ideal and non-ideal reactors using E- and F-curves

CO2: Determine the mean residence time and standard deviation using residence time distribution (RTD) data

CO3: Analyse the performance of non-ideal reactors using segregation model, tanks-in series model and dispersion model

CO4: Understand the effect of velocity, particle size and fluid properties on rate of reactions controlled by mass transfer

CO5: Design fixed bed reactors involving chemical reactions with mass transfer

CO6: Determine internal and overall effectiveness factors

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO6	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed syllabus:

Unit I

Conversion and Reactor Sizing : Definition of the rate of reaction, General mole balance equation, Batch Reactors, Continuous-flow reactors, Industrial reactors, Definition of conversion, Design equations, Applications of the design equations for continuous-flow reactors.

Unit II

Rate-Law and Stoichiometry: Basic definitions, Approach to reactor sizing and design, Stoichiometric table, expressing concentrations in terms other than conversion, Reactors in series, Reactions with phase change

Unit III

Isothermal Reactor Design: Design structure for isothermal reactors, Scale up of liquid-phase batch reactor data to the design of a CSTR, Tubular reactors, Recycle reactors.

Unit IV

Collection and Analysis of Rate Data: Batch reactor data, Method of initial rates, Method of half-life, Differential reactors, least square analysis.

Unit V

Catalysis and Catalytic Reactors: Catalysts, Steps in a catalytic reaction, Synthesizing a rate law, mechanism and rate-limiting step, Design of Reactors for gas-solid reactions, Heterogeneous data analysis for reactor design.

Texts / References:

1. H. S. Fogler, "Elements of Chemical Reaction Engineering", 3rd Ed, New Delhi- Prentice Hall, 2001
2. O. Levenspiel," Chemical Reaction Engineering" Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, "Chemical Engineering Kinetics

Petrochemical Technology **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PC504	Petrochemical Technology	3	-	-	20	20	60	100	03

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand petrochemical Industries ,its requirement and usefulness
CO2: Understand manufacturing of petrochemical feedstock
CO3: Understand technology for different petrochemicals
CO4: Asses environmental impact of different products
CO5: Understand hazard and safety associated in chemical processes
CO6: Understand the scenario of petrochemical industry in India

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	✓	-	-	-	-	-	-
CO2	✓	✓	-	-	-	✓	✓	-	-	-	-	-
CO3	✓	✓	-	-	-	✓	✓	-	-	-	-	-
CO4	✓	✓	-	-	-	✓	✓	-	-	-	-	-
CO5	✓	✓	-	-	-	✓	✓	-	-	-	-	-
CO6	✓	✓	-	-	-	✓	✓	-	-	-	-	-

Detailed syllabus:

Unit I
Scenario of Petrochemical Industries and its feed stock. Product pattern of paraffin's, olefins, diened and acetylene

Unit II
Manufacture of important paraffin's, olefins, acetylene, butadiene, isoprene and oligomers and aromatics: Techniques, Equipment, Reactions, Catalyst, Solvents, Operating conditions, Separation and purification and developments in these areas.

Unit III
Production of synthesis gas: Various routes, reactions, mechanism, condition, thermodynamics, kinetics, coal gasification and hydrogenation.

Unit IV
Conversion of Ethylene to ethylene oxide, ethylene glycol, ethanol amine. Propylene to acrylic acid, methyl ethyl ketone, acrylonitrile
Hydration: Technologies for production of alcohols such as ethanol, isobutyl alcohol and higher alcohols.

Unit V
Conversion of Butenes to iso and n butanols, MIBK, MTBE, Aromatics to maleic and phathalic anhydride, DMT, phenols and acetones, Cyclohexane to caprolactum, adipic acid, succinic acid Esterification: Process for production of few esters such as acrylates, terephthalates, ester for flavoring industries etc.

Texts/ References:

1. N.N. Lebdev, Chemistry and techno logy of basic organic and petrochemical synthesis, Vol. 1 & 2 Mir publications, Moscow
2. Dryden, Charles E., Outlines of Chemical Technology, affiliated East-West Press Pvt. Ltd. New Delhi
3. B.K. Bhaskarrao, "A text on Petrochemicals" 2nd Ed, Khanna publishers, New Delhi.
4. G.N. Sarkar, "Advanced Petrochemicals" 1st Ed, Khanna Publishers, New Delhi

Open Elective III
From University Open Elective Bucket

(A) Corporate Communication **03 Credits**

Category Faculty of Management and Commerce									
Code	**Subject Name**	**L**	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**Credits**

25UD1MACOEM05K	**Corporate Communication**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**03**
NPTEL Link https://onlinecourses.swayam2.ac.in/nou25_cm19/preview									

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand corporate communication culture
CO2: Prepare business letters, memos and reports
CO3: Communicate effectively in formal business situations
CO4: Exhibit corporate social responsibility and ethics
CO5: Practice corporate email, mobile and telephone etiquette
CO6: Develop good listening skills and leadership qualities

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	-	-	-	-	-	-	-	-	√	-	-
CO2	-	-	√	-	√		-	-	-	√	-	-
CO3	-	-	√	-	√	√	-	-		√	-	-
CO4	-	-	√	-	√	√	-	√		-	√	-
CO5	-	-	-	-	-	-	-	√	-	-	√	-
CO6	-	-	-	-	-	-	-	√	-	-	√	-

Detailed Syllabus:

Unit I
Importance of Corporate communication: Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

Unit II
Oral Communication: Techniques for improving oral fluency-Speech mechanics- Group Dynamics and Group Discussion – Debate and oral presentations.

Unit III
Written Communication: Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Unit IV
Corporate responsibility: Circulating to employees' vision and mission statements- ethical practices- Human rights -Labour rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders. **Corporate Ethics and Business Etiquette:** Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Unit V

Listening Skills: Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening. **Leadership Communication Styles:** Business leadership -Aspects of leadership- qualities of leader- training for leadership-delegation of powers and ways to do it-humour- commitment.

Texts and Reference Books

1. Raymond V. Lesikar, John D. Pettit, Marie E. Flatley Lesikar's Basic Business Communication - 7th Edition: Irwin, 1993
2. Krishna Mohan and Meera Banerji, Developing Communication Skills: Macmillan Publishers India, 2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edition Tata McGraw-Hill, 2008
4. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
   Shirley Taylor, Communication for Business, Longman, 1999

(B) Basic Principle of Finance and Economy **03 Credits**

Category Faculty of Management and Commerce									
Code	**Subject Name**	**L**	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**Credits**
25UD1MACOEM05K	**Basic Principle of Finance and Economy**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**03**
NPTEL Link https://onlinecourses.nptel.ac.in/noc23_ec06									

Course Outcomes:

Students will be able to:

1. Students will be able to know and apply accounting and finance theory.
2. Students will be able to understand the mechanics of preparation of financial statements, their analysis and interpretation
3. Students will be able to explain basic economic terms, concepts, and theories
4. Students will be able to identify key macroeconomic indicators

Detailed syllabus:

Unit I

Introduction: Explaining the Economy. The Supply and Demand Model Using the Supply and Demand Model

The Competitive Equilibrium Model: Deriving Demand Deriving Supply, Market Equilibrium and Efficiency

Unit II

Deviations from Competition: Monopoly and Market Power between Monopoly and Competition Antitrust Policy and Regulation

Unit III

Macro facts and measures: Getting Started with Macroeconomic Ideas, Measuring Production, Income and Spending of Nations

Unit IV

Accounting Transaction: Journal entries Debit credit rules, Compound journal entry Journal and ledger Rules of posting entries Trial balance

Unit V

Capital and Revenue: Income and expenditure Expired costs and income Final accounts, Manufacturing accounts Trading accounts, Profit and Loss account Suspense account, Balance sheet, Concept of Depreciation.

(C) Waste to Energy **03 Credits**

Category Faculty of Science									
Code	**Subject Name**	**L**	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**Credits**
25UD1MACOEM05K	**Waste to Energy**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**03**
NPTEL Link https://onlinecourses.nptel.ac.in/noc20_ch16									

Detailed Syllabus

Unit I

Introduction, characterization of wastes, Energy production form wastes through incineration, energy production through gasification of wastes.

Unit II

Energy production through pyrolysis and gasification of wastes, syngas utilization. Densification of solids, efficiency improvement of power plant.

Unit III

Energy production from waste plastics, gas clean up, Energy production from organic wastes through anaerobic digestion and fermentation,

Unit IV

Introduction to microbial fuel cells, Energy production from wastes through fermentation and transesterification.

Unit V

Cultivation of algal biomass from wastewater and energy production from algae.

Books and References:

1. Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store.
2. Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons.
3. Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc.
4. EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science.
5. Hall, D.O. and Overeed, R.P.," Biomass - Renewable Energy", John Willy and Sons.
6. Mondal, P. and Dalai, A.K. eds., 2017. Sustainable Utilization of Natural Resources. CRC Press.

MDM III- Petroleum Products -I **03 Credits**

Category	**Code**	**Subject Name**	**L**	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**Credit**
MDM	**25UD1527MD506**	**Petroleum Products -I**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**03**

Detailed syllabus:

Unit I: Gases Natural Ga , LNG,CNG, LPG . Uses of petroleum gases

Unit II: Naphtha, Gasoline

Unit III: Kerosene

Unit IV: Diesel Fuels

Unit V: Domestic fuels

(Note : All above petroleum products to be taught / learned with reference to the points as definition, specification, important tests and their significance)

Text Books:

1. BK Bhaskar Rao , Modern Petroleum Refining Processes, Sixth edition,Oxford & IBH Publishing Co. Pvt . LTd.

2. G. K. Ghosal Modern Petroleum Refining Technology, Denett & Co.Nagpur

PEC- I

A) Numerical Methods and Computer Programming 02 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE507	Numerical Methods and Computer Programming	2	-	-	20	20	60	100	02

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Common numerical methods and how they are used to obtain approximate solutions.
2. Numerical methods to obtain approximate solutions to mathematical problems
3. Numerical methods for various mathematical operations like interpolation, differentiation etc.
4. Accuracy of common numerical methods.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions.

CO2: Apply numerical methods to obtain approximate solutions to mathematical problems

CO3: Derive numerical methods for various mathematical operations like interpolation, differentiation etc.

CO4: Analyse and evaluate the accuracy of common numerical methods.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	-	-	✓	-	✓	-	-	-	-	-	-
CO2	✓	-	-	✓	-	✓	-	-	-	-	-	-
CO3	✓	-	-	✓	-	✓	-	-	-	-	-	-
CO4	✓	-	-	✓	-	✓	-	-	-	-	-	-

Detailed syllabus:

Unit I

Solutions of Linear Algebraic Equations - Gauss elimination and LU decomposition, Gauss- Jordan Elimination, Guass-Seidel and relaxation methods.

Eigen values and Eigen Vectors of Matrices - Faddeev-Leverrier method, Power method, Householder's and Given's method

Unit II

Nonlinear Algebraic Equations - Fixed point method, Multivariable successive substitutions, Single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique

Unit III

Function Evaluation - Least-squares curve fit, Newton's Interpolation formulae, Newton's divided difference interpolation polynomial, Langrangian interpolation, Pade approximations, Cubic spline approximations

Unit IV

Ordinary Differential Equations (Initial value problems) – RungeKutta Methods, Semi-implicit Runge Kutta Techniques, Step size control and estimates of error

Ordinary Differential Equations (Boundary value problems) - Finite difference technique, Orthogonal collocation technique, Orthogonal collocation on finite elements

Unit V

Partial Differential Equations – Introduction to finite difference technique

Texts / References:

S. K. Gupta, "Numerical Methods for Engineers", Wiley Eastern, 1995.

M. E. Davis, "Numerical Methods and Modeling for Chemical Engineers", Wiley, 1984

B) Introduction to Catalysis **02 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE507	Introduction to Catalysis	2	-	-	20	20	60	100	02

Detailed syllabus:

Unit I

Introduction to catalysis, application to industrial processes- one examples each from inorganic, fine organic chemical petroleum refining, petrochemical and biochemical industries. Types of catalysis: homogeneous Catalysis.

Unit II

Heterogeneous catalysis: Introduction, phase transfer and tri-phase catalysis, liquid- liquid and slid liquid catalysis, mechanism, engineering problems, mass transfer considerations and reactor types.

Unit III

Gas – Solid catalytic reactions: adsorption theories and concept of active site. Adsorption isotherm and Langmuir – Hinshelwood approach, diffusion effects in the catalyst.

Unit IV

Preparation of catalysts- supported metal and metal oxide catalyst, Major steps involved in catalysts preparation and formation, physical methods of catalyst characterization for determination of surface area by bet method, pore volume and average pore size distribution, effectiveness of the catalyst, selectivity of the catalyst, deactivation of catalyst, mechanism of catalyst poisoning.

Unit V

Zeolites – structural chemistry of zeolites, template molecular sieves, size and shape selectivity, a few industrial applications of zeolites, modification of zeolites.

Biocatalysts – enzymes, lipases and microbes as catalyst, mechanism of participation of enzymes in few typical reactions, Michaelis – Menten Kinetics, inhibition of enzyme reaction and kinetics.

Reference Books:

1. Smith J. M,: 'Chemical Engineering Kinetics", 3rd Edition, McGraw Hill.
2. Satterfield Charles N.: Heterogeneous Catalysis in industrial practices, McGraw- Hill International Editions, 2nd Edition 1993.
3. Bailey James, Davis Ollis:'Biochemical Engineering", McGraw Hill.
4. Wingard I. B.: Enzyme Engineering, Fr. Inter Science. Y. 1972
5. Caberry J. J.: Chemical and Catalytic Reaction Engineering, McGraw Hill, New York,1976.

C) Materials for Engineering Applications 02 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE507	Materials for Engineering Applications	2	-	-	20	20	60	100	02

Detailed Syllabus:

Unit I

Advanced metallic systems, steels for special applications, au tempered ductile iron.

Advanced polymeric materials, new polymeric materials such as Kevlar, Nomex, UHMWPE and fiber technology.

Unit II

Advanced ceramic materials, advanced powder synthesis techniques, advanced processing methods, micro structural design and grain boundary engineering, case studies.

Unit III

Introduction to composite materials, factors influencing the properties of composite materials like fiber parameter, matrix, interface & molding methods. Phase selection criteria. Reinforcing mechanism. Interfaces, advantages and disadvantages. Polymer composites, Reinforcing and matrix materials, prepregs, fiber winding techniques, fabrication techniques, laminates, mechanical behavior etc.

Unit IV

Metal composites, types of reinforcement, chemical compatibility, fabrication processes, mechanical behavior and properties, ceramics composite. Matrices and reinforcement. Why to reinforce ceramics, fabrication methods, crack propagation and mechanical behavior.

Unit V

Carbon composite, their properties, fabrication methods and their applications, ablative polymers, their applications, air craft materials, introduction to nonmaterial, synthesis & characterization of nonmaterial with special Refences to chemical engineering.

Reference Books:

1. Modern Ceramic Engineering, Richorson R. W. Marcel Dekker.
2. Composite Materials, Chawala K. K. Springer Science & Business Media.
3. FRP Technology, Weather head R. Applied Science Publishers.
4. Engineering Polymers, Dyson R. W. Springer Science & Business Media.
5. Polymers of high technology, electronic and photonics Bowden MJ & Turner S. R. ACS Symp.Ser.346,1987.

Chemical Engineering Laboratory-I **01 Credit**

(Includes the practicals of Chemical Reaction Engg-I and Mass Transfer Operations–I)

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PCL508	Chemical Engg. Laboratory – I	-	-	2				100	01

Students are supposed to do practices related to Chemical Reaction Engg-I and Mass Transfer Operations-I.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Understand and calculate activation energy for given reaction
CO2: Determine rate of reaction and parameter affecting the rate.
CO3: Understand kinetic of different reaction
CO1: Determine efficiency of steam distillation
CO2: Plot mutual solubility curve for acetone-methyl-iso-butyl-ketone and water
CO3: Determine the overall plate efficiency of sieve plate distillation
CO4: Verify Rayleigh's equation for batch distillation
CO5: Determine HETP and HTU for given packing for distillation of benzene-acetone mixture under total reflux
CO6: Determine the critical moisture content in drying

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	✓	-	✓	-
CO2	✓	-	✓	-	-	-	-	-	✓	-	✓	-
CO3	✓	-	✓	-	-	-	-	-	✓	-	✓	-
CO4	✓	-	✓	-	-	-	-	-	✓	-	✓	-
CO5	✓	-	✓	-	-	-	-	-	✓	-	✓	-
CO6	✓	-	✓	-	-	-	-	-	✓	-	✓	-

List of Practical's:

1. To determine the diffusivity of acetone in air
2. To determine the diffusivity of carbon tetra chloride in air
3. To study the absorption with chemical reaction in packed bed
4. To study multistage cross-current leaching operation for calcium carbonate, sodium hydroxide water system.
5. To draw equilibrium solubility diagram for an acetic acid, benzene, water. and benzene(C) system
6. To study liquid-liquid extraction in packed bed (HTU/NTU)
7. To study the physical absorption in packed bed (HTU/NTU)
8. Determine activation energy of acid catalysed hydrolysis of methyl acetate.
9. To study effect of concentration of reactant and temperature on the rate of reaction.
10. To determination of specific reaction rate of acid catalyzed hydrolysis of ethyl acetate
11. Determination of specific reaction rate of acid catalyzed hydrolysis of ethyl acetate by sodium hydroxide at 298 K
12. To study the reaction between potassium persulphate and iodide
13. Kinetics of hydrolysis of methyl acetate by strong acid.
14. To study saponification of ethyl acetate.
15. Study of Isothermal continuous stirred tank reactor

Petroleum Engineering Laboratory - II **01 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	**25UD1527PCL509**	**Petroleum Engineering Laboratory - II**	**-**		**2**				**100**	**01**

Course Outcomes:
At the end of the course, the student will be able to:

CO1: Understand product tests methods and their significance

CO2: Perform experiment related to distillation, calorific value

CO3: Perform and analyse experimental results

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓			✓					
CO2	✓	✓		✓			✓					
CO3	✓	✓		✓			✓					

List of Practical's:

1. To determine the Rams bottom Carbon Residue of given petroleum sample
2. To determine the Drop point of given petroleum product.
3. To determine the Conrandson carbon residue of given petroleum sample.
4. To determine the calorific value of given petroleum product by Bomb Calorimeter.
5. To determine the ASTM distillation curve for given petroleum product.
6. Determination of % aromatics in given petroleum sample by Aniline Point Method.
7. To study the method for determination of hydrocarbon type (PONA Analysis) in liquid
8. Petroleum product by Fluorescent Indicator Adsorption Method.
9. To study the method for determination of surface area of catalyst sample by BET technique.
10. To determine the penetration index of given grease sample
11. To determine the vaporization characteristics of given petroleum product by TBP distillation.

Mini Project – I **01 Credit**

(Industrial Training - I Evaluation (Assessment PP or NP grades)

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527MP510	Mini Project – I	-		2				100	01

Course objective

At the end of the course, students will be able to:

CO1: Acquire knowledge on topics outside the scope of curriculum training

CO2: Communicate with group of people on different topics of training

CO3: Collect and consolidated required information on a topic of training

CO4: Prepare a seminar report on training

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓			-	-	-	-	
CO2	✓	✓	-	-			-	-				
CO3	✓	✓	✓	✓				-	-	-		
CO4	✓	✓	-	✓	-			-	-	-		

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of semester V (during vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc.

The student shall submit the report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and appropriate grade shall be awarded.

SEMESTER – VI

Chemical Reaction Engineering – II **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PC601	Chemical Reaction Engineering – II	3	-	-	20	20	60	100	03

Course Outcomes:

At the end of the course, students will be able to:

CO1: Compare the performance of ideal and non-ideal reactors using E- and F-curves.

CO2: Determine the mean residence time & standard deviation using residence time distribution(RTD)

CO3: Analyse the performance of non-ideal reactors using segregation model, tanks-in series model and dispersion model

CO4: Understand the effect of velocity, particle size and fluid properties on rate of reactions controlled by mass transfer

CO5: Design fixed bed reactors involving chemical reactions with mass transfer

CO6: Determine internal and overall effectiveness factors

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO6	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed Syllabus:

Unit I
Multiple Reactions: Maximizing desired product in parallel reactions, Maximizing desired product in series reactions, Stoichiometric table using fractional conversion
Multiple reactions in PFR and CSTR – An alternative approach to using fractional conversion

Unit II
Non-elementary Reaction Kinetics: Fundamentals, Searching for a mechanism, polymerization, enzyme reaction fundamentals, Bioreactors

Unit III
External Diffusion Effects on Heterogeneous Reactions: Mass transfer fundamentals, Binary diffusion, External resistance to mass transfer, the shrinking core model

Unit IV
Distribution of Residence times for Chemical Reactors: General characteristics, Measurement of RTD, Characteristics of RTD, RTD in ideal reactors.

Unit V

Models for non-ideal reactors: Reactor modeling with RTD, Zero-parameter models One-parameter models; tank-in-series model, dispersion model

Texts / References:

1. H. S. Fogler, "Elements of Chemical Reaction Engineering", 3rd Ed, New Delhi- Prentice Hall, 2001
2. O. Levenspiel," Chemical Reaction Engineering" Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, "Chemical Engineering Kinetics", 3rd Ed., McGraw- Hill, 1988

Process Instrumentation and Control **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PC602	Process Instrumentation and Control	3		-	20	20	60	100	03

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Close loop and open loop systems, dynamics of first order systems
2. Transient response of control systems
3. Frequency response analysis and controller tuning
4. Characteristics of measurement systems with pressure measurement
5. Temperature, flow and level measurement

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand the dynamic behaviour of different processes
CO2: Analyse different components of a control loop
CO3: Analyse stability of feedback control system
CO4: Design controllers for first and second order processes
CO5: Analyse frequency response for controllers and processes
CO6: Understand the measurement techniques for Pressure and Temperature
CO7: Understand the measurement techniques for Flow and Level
CO8: Understand recording, indicating and signalling instruments
CO9: Analyse repeatability, precision and accuracy of instruments

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-

CO6	✓	-	✓	✓	✓	-	-	-	-	-	-	-
CO7	✓	-	-	✓	✓	-	-	-	-	-	-	-
CO8	✓	-	-	✓	✓	-	-	-	-	-	-	-
CO9	✓	-	-	✓	✓	-	-	-	-	-	-	-

Detailed syllabus:

Unit I
Closed loop and open loop control systems, Dynamics of first order systems using transfer functions; Response of thermometer bulb, General response to step, ramp, impulse, and sinusoidal inputs; Concentration and temperature responses of a stirred tank.

Unit II
Linearization of liquid level systems; Response of pressure systems, second order systems, the manometer; Response of interacting and non-interacting systems, Transient response of control systems: Servo and regulated operation, General equations for the transient response.

Unit III
Feedback control, Proportional control of a signal capacity process; Integral control, Proportional-integral control and derivative action, Stability: Concept of stability, Stability criterion, Routh test for stability. Root locus analysis: Concept of root locus, Locus diagram.

Unit IV
Frequency response analysis: First order systems, Bode diagram, Complex numbers to get frequency response. Controller selection and tuning, Control valve characteristics and sizing, Cascade control, feed forward control, Introduction of digital control principles.

Unit V
Introduction to measurements, Elements of measuring systems and their functions, Single transmission, Transmitters- electronic pneumatic etc., Temperature measurement, Pressure measurement , Flow measurement, Level measurement.

Texts / References:

1. D. R. Coughanour, Process system analysis and control, 2nded, McGraw Hill, 1991.
2. P. Harriott, Process Control, Reprint of text, ed. Tata McGraw Hill, 1983.
3. G. Stephanopoulos, Chemical Process Control: An introduction to theory and practice, Prentice Hall, New Jersey, 1984.
4. Patranabis D, Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 1999.
5. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, 1st Edition, Tata McGraw-Hill Education Private Limited, 2009.
6. Eckman Donald P., Industrial Instrumentation, Wiley Eastern Ltd., 2004.

Mass Transfer Operations – II **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	**25UD1527PC603**	**Mass Transfer Operations – II**	**3**		**-**	**20**	**20**	**60**	**100**	**03**

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Distillation, flash and differential distillation
2. McCabe Thiele method and Ponchon Savarit method to do calculations of distillation
3. Humidification operations and cooling tower design
4. Drying and different types of dryers
5. Crystallization basics and membrane separation processes

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Select solvent for absorption and extraction operations

CO2: Determine number of stages in distillation, absorption and extraction operations

CO3: Determine the height of packed column in absorption, distillation and extraction

CO4: Calculate drying rates and moisture content for batch and continuous drying

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed Syllabus:

Unit I
Distillation - Vapour liquid equilibria, flash vaporization, batch distillation, differential distillation. Continuous fractionation - Binary systems,

Unit II
Mc-Cabe Thiele and Ponchon Savarit method calculations with multiple feeds and withdrawal, Multi component Distillation

Unit III
Humidification- Vapour liquid equilibrium, enthalpy for pure substances, vapour gas contact operation. Psychrometric charts and measurement of humidity
Dehumidification and Cooling Tower Design - Adiabatic and non adiabatic operations evaporative cooling, cooling tower design and dehumidification methods

Unit IV
Drying and Crystallization - Drying equilibrium and rate of drying, drying operation batch and continuous number of transfer units. Theories of crystallization, nucleation and crystal growth principles of super saturation, different types of dryers and crystallizers

Unit V
Membrane separation Processes: Types of membranes for osmosis and dialysis; Mechanism of solute/solvent rejection in the process; Design of R.O. and dialysis units; applications.

Texts / References:

1. R. E. Treybal, Mass transfer operations, 3ed ed. McGraw Hill, 1980.
2. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 ELBS, Pergamon press, 1970
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergamon press, 1970

Petrochemical Engineering –II **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	25UD1527PC604	Petrochemical Engineering –II	3	-	-	20	20	60	100	03

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand working types and calculate heat duty for pipe still heaters
CO2: Understand the equilibrium of multicomponent systems
CO3: Design distillation column for multicomponent system
CO4: Understand different types of distillation column ,and to do inter-conversion of data

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed Syllabus:

Unit I
Flash distillation, Dew point and Bubble point calculations, temperature and concentration profile in a distillation column.

Unit II
Multicomponent distillation, Calculation of number of stages in distillation, Key component concept, Comparison between multicomponent distillation and petroleum distillation

Unit III
Distillation curves and their interconversion at atmospheric, sub atmospheric and super atmospheric pressure, Collection and data for distillation column design and operation etc.

Unit IV
Atmospheric distillation, principles and mode of excess heat removal, Flash zone calculation and estimation of side draw tray temperatures, Design aspects, Post treatment of straight run products.

Unit V
Vacuum distillation column internals and operational aspects for lubes, asphalt, cracking feedstock, Pressure distillation and gas fractionation units, Difference between various types distillation regaining products of pressure distillation.

Text Book/Reference Book:

1. B. K.Bhaskar Rao, Modern Petroleum Refining Processes, Oxford & IBH (2006)
2. W.L. Nelson, Petroleum Refinery Engineering, McGraw –Hill, 1964
3. 3 M. Van winkle, Distillation, McGraw –Hill, 1961

PEC II

A) Energy Management in Petrochemical Industries 03 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE605	Energy Management in Petrochemical Industries	3	-	-	20	20	60	100	03

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Energy use pattern, management and problems
2. Energy conservation economics
3. Energy audit

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Gain knowledge of energy problem
CO2: Understand energy management principles and latest technology
CO3: Understand conceptually energy conservation economics
CO4: Apply primary energy sources and their optimum utilization

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	✓	✓	-	-	-	-	-	-
CO2	✓	✓	✓	-	✓	✓	-	-	-	-	-	-
CO3	✓	✓	-	-	✓	✓	-	-	-	-	-	-
CO4	✓	✓	-	-	✓	-	-	-	-	-	-	-

Detailed syllabus:

Unit I

General energy problems, energy use patterns and scope for conservation, energy management principles

Unit II

Needs of organization and goal setting, energy audit in plant metering, review of conservation technologies. Properties of Hydrogen with respect to its utilizationas a renewable form of energy

Unit III

Energy conservation economics, basic discounting life cycle, costing and other methods, factors affecting economics

Unit IV

Energy pricing and incentives for conservation of energy, energy conservation of available work in the plants, identification of irreversible processes

Unit V

Primary energy sources, optimum use of prime movers, energy efficient housekeeping, energy recovery in thermal systems, energy storage, thermal insulation.

Texts/ References:

1. D.A.Reay , Industrial Energy Conservation ,Pergamon press,1980
2. T.L. Boyen , Thermal Energy Recovery ,Wiley , 1980

B) Catalytic Processes in Petrochemical Industry 03 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**25UD1527PE605**	**Catalytic Processes in Petrochemical Industry**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**03**

Detailed syllabus:

Unit I

Introduction to catalysis, application to industrial processes – one example each from inorganic, fine organic chemical, petroleum refining, petrochemical and biochemical industries. Types of catalysis: homogeneous catalysis.

Unit II

Heterogeneous Catalysis: Introduction, phase transfer and tri-phase catalysis, liquid – liquid and solid – liquid catalysis, mechanism, engineering problems, mass transfer considerations and reactor types.

Unit III

Gas – Solid Catalytic Reactions: adsorption theories and concept of active site. Adsorption isotherm and Langmuir – Hinshelwood approach, diffusion effects in the catalyst.

Unit IV

Preparation of Catalysts: Supported metal and metal oxide catalyst. major steps involved in catalysts preparation and formation, physical methods of catalyst characterization for determination of surface area by bet method, pore volume and average pore size distribution, effectiveness of the catalyst, selectivity of the catalyst, deactivation of catalyst, mechanism of catalyst poisoning.

Unit V

Zeolites: Structural chemistry of Zeolites, templated molecular sieves, size and shape selectivity, a few industrial applications of Zeolites, modification of Zeolites.

Biocatalysts: Enzymes, lipases and microbes as catalysts, mechanism of participation of enzymes in a few typical reactions, Michaelis – Menten kinetics, inhibition of enzyme reaction and kinetics.

Reference Books:

1. Smith J.M.: “Chemical Engineering Kinetics”, 3rd Edition, McGraw Hill
2. Satterfield Charles N.: Heterogeneous Catalysis in Industrial Practices, McGraw- Hill International Editions, 2nd Edition 1993.
3. Bailey James, Davis Ollis: “Biochemical Engineering”, McGraw Hill
4. Wingard L.B.: Enzyme Engineering, Fr. Inter Science, N.Y. 1972.
5. Carberry J. J.: Chemical and Catalytic Reaction Engineering, McGraw Hill, New York, 1976. BE (Chemical Engineering)-2019 Course**.**

C) Introduction to Nanotechnology **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE605	Introduction to Nanotechnology	3	-	-	20	20	60	100	03

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Properties of nano-materials and their applications
2. Chemical engineering principles to nano-particles production and scale-up
3. Quantum confinement equations
4. Characterization of nano-materials.
5. Applications of nanotechnology in electronics and chemical industries.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the properties of nano-materials and their applications

CO2: Apply chemical engineering principles to nano-particles production and scale-up

CO3: Solve the quantum confinement equations

CO4: Characterize nano-materials.

CO5: State the applications of nanotechnology in electronics and chemical industries.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	-	-	-	-	-	-	-	-	-
CO2	√	√	√	√	√	√	√	-	-	-	-	-
CO3	√	-	-	-	-	-	√	-	-	-	-	-
CO4	√	√	√	√	-	√	-	-	-	-	-	-
CO5	√	√	√	√	√	√	√	√	√	√	√	-

Detailed syllabus:

Unit I

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano sizes and properties comparison with the bulk materials, different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach, Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Unit II

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH.

Unit III

Carbon Nanomaterials: Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones Difference between Chemical Engineering processes and nanosynthesis processes.

Characteristics of quantum dots, Synthesis of quantum dots, Semiconductor quantum dots, Introduction - Nanoclay Synthesis method, Applications of nanoclay.

Unit IV

Nanomaterials characterization: Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential Microscopy's SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy

Unit V

Applications in Chemical Engineering: Self-assembly and molecular manufacturing : Surfactant based system Colloidal system applications, ZnO,TiO2, Silver Nanoparticles Functional materials Applications, Production Techniques of Nanotubes, Carbon arc, bulk synthesis, commercial processes of synthesis of nanomaterials, Nanoclay, Commercial case study of nano synthesis - applications in chemical engineering, Nano inroganic materials - CaCO3 synthesis, Hybrid wastewater treatment systems, Electronic Nanodevices, sensor applications, Nanobiology: biological methods of synthesis.Applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nanomaterials, Environmental Impacts, Case Study for Environmental and Societal Impacts.

Texts /References:

1. Kulkarni Sulabha K., Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
5. Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.

MDM IV - Petroleum Products -II **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
MDM	25UD1527MD606	Petroleum Products -II	3	-	-	20	20	60	100	03

Detailed syllabus:

Unit I: Fuel oils

Unit II : Lubricating oils

Unit III: Lubricating greases

Unit IV: Petroleum waxes, Bitumen

Unit V : Special products

(Note: All above petroleum products to be taught / learned with reference to the points as definition, specification, important tests and their significance).

Text Books:

1. BK Bhaskar Rao , Modern Petroleum Refining Processes, Sixth edition,Oxford & IBH Publishing Co. Pvt . LTd.

2. G.K. Ghosal Modern Petroleum Refining Technology, Denett & Co.Nagpur

PEC III

A) Heat Transfer Equipment Design **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE607	Heat Transfer Equipment Design	3	-	-	20	20	60	100	03

Course Objectives:
After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Process design of double pipe heat exchanger
2. Process design of Shell and Tube heat Exchanger
3. Process design of condenser and reboiler
4. Process design of evaporator
5. Process design of agitator

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand different type of heat transfer equipment
CO2: Design of heat transfer equipment
CO3: Compare and evaluate design of equipment
CO4: Apply knowledge of selection of equipment

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO2	✓	✓	-	-	✓	-	✓	-	-	-	-	-
CO3	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO4	✓	✓	-	-	✓	-	✓	-	-	-	-	-

Detailed Syllabus:

Unit I
Detailed Process Design of Double Pipe Heat Exchangers
Detailed Process Design of Shell and Tube heat exchanger

Unit II
Detailed Process design of condenser

Unit III
Detailed Process Design of Evaporator

Unit IV
Detailed process design of Agitator

Unit V
Detailed process design of Reboiler

Texts / References:
1. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergamon Press, 1970
2. D. Q. Kern, "Process Heat Transfer", McGraw Hill, 1950.

B) Fertilizer Technology **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE607	Fertilizer Technology	3	-	-	20	20	60	100	03

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Classify fertilizers
CO2: Explain manufacturing processes involved in production of fertilizers
CO3: Identify the effect of technologies on the health, safety and environment
CO4: State the chemical reactions and their mechanism involved

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓					✓					
CO2	✓	✓					✓					
CO3	✓	✓					✓					
CO4	✓	✓					✓					

Detailed Syllabus:

Unit I
Introduction Elements required for plants growth, Classification of fertilizers, Compound, Complex and bulk blended fertilizers. N-P-K values and calculations.

Unit II
Nitrogenous Fertilizers: Manufacturing Processes for Ammonia, Manufacture of ammonium sulphate, ammonium chloride, Ammonium phosphate, Ammonium nitrate, nitric acid, Urea etc. Economics and other strategies, Material of construction and corrosion problem.

Unit III
Phosphatic fertilizers: Calculation of percentage tricalcium phosphate of lime in phosphatic rock: Manufacture of triple super phosphate and single super phosphate,

Unit IV
Nitro phosphate, Sodium phosphate, phosphoric acid and other phosphatic fertilizers.

Unit V
Potash Fertilizers: Manufacture of potash fertilizers like potassium sulphate, potassium chloride etc.

Reading:

1. Sittig M and GopalaRao M., Dryden's Outlines of Chemical Technology for the 21st Century, 3rd Edition, WEP East West Press, 2010.
2. Austin G T., Shreve's Chemical Process Industries, McGraw Hill Book Company, New Delhi, 5th Edition, 1986.
3. Shukla S D and Pandey G N, A Text Book of Chemical Technology, Vol I & II, Vikas Publishing House Pvt. Ltd., New Delhi, 2000

C) Pharmaceutical and Fine Chemicals **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	25UD1527PE607	Pharmaceutical and Fine Chemicals	3	-	-	20	20	60	100	03

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Different grades of chemicals
2. Different methods of preparation of reagents and laboratory chemicals
3. Uses and testing of the pharmaceuticals and fine chemicals
4. Manufacture of Pharmaceuticals and fine chemicals with flow sheets
5. Study compressed tablet making and coating techniques
6. Study Preparation of capsules and extraction of crude drugs

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Know different grades of chemicals
CO2: Understand different methods of preparation of reagents and laboratory chemicals
CO3: Know uses and testing of the pharmaceuticals , fine chemicals and their applications
CO4: Know the techniques for manufacture of Pharmaceuticals and fine chemicals with flow sheets and their applications
CO5: Tablet making and coating techniques
CO6: Know Industrial procedures of capsule formulation and methods of recovering the drug formulated from the reaction mixture

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	-	-	-	-	-	-	-
CO2	✓	✓	-	-	-	-	-	-	-	-	-	-
CO3	✓	✓	-	-	-	-	-	-	-	-	-	-
CO4	✓	-	-	✓	-	-	-	-	-	-	-	-
CO5	✓	-	-	✓	-	✓	-	-	-	-	-	-
CO6	✓			✓		✓						

Detailed Syllabus:

Unit I

A brief outline of different grades of chemicals – Reagent grade and Laboratory grade. Outlines of preparation – Different methods of preparation of Reagent grade and Laboratory grade Chemicals.

Unit II

Uses and testing of the pharmaceuticals and fine chemicals – Applications of medicinal value Chemicals and their quality testing procedures.

Unit III

Properties, assays and manufacture of Pharmaceuticals and fine chemicals with flow sheets- Physical and Chemical properties, methods of assessing the quality and industrial methods of formulating the drugs and fine chemicals that have no medicinal value but are used as the intermediates.

Unit IV

Compressed Tablet making and coating – Types of tablets and Methods of compressed tablet making and coating.

Unit V

Preparation of capsules and extraction of crude drugs – Industrial procedures of capsule formulation and methods of recovering the drugs formulated from the reaction mixture. Sterilization – Need for sterilization, Sterilization methods, batch and continuous sterilization.

Text / References:

1. Remington, Pharmaceutical Sciences, Mak. Publishing Co., 16th Edition, 1980.
2. William Lawrence Faith, Donald B. Keyes and Ronald L. Clark, Industrial Chemicals, 4th Edition, John Wiley & Sons, 1975.
3. Gurdeep R. Chatwal, Synthetic Drugs, Himalaya Publishing House, 2002.

Chemical Engg. Laboratory – II **01 Credit**

Students are supposed to perform the experiments related to Mass transfer Operations-II and Chemical rection Engg.-II

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
VSEC	**25UD1527PCL608**	**Chemical Reaction Engineering Laboratory – II**	**-**	**-**	**2**					**01**

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Determine the kinetics of chemical reaction in Batch reactor, CSTR, PFR

CO2: Determine the kinetics using Dilatometer

CO3: Determine the temperature dependency of reaction rate constant

CO4: Analyse the performance of reactors through RTD studies

CO5: Compare the performance of CSTR-PFR with PFR-CSTR reactor systems

CO6: Compare the performance of single CSTR with series of CSTRs

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓			✓					
CO2	✓			✓								
CO3	✓			✓			✓					
CO4	✓			✓								

List of Practical's:

1. T-x-y diagram for water-acetone system
2. To prove Rayleigh equation by carrying out simple distillation of methanol-water system
3. To carry out crystallization of given salt
4. To determine rate of drying of given sample and to plot (kg moisture content/ kg of dry solid) V/S time and rate of drying V/S time
5. To study Swenson Walker crystallizer
6. Determination of HETP (Height equivalent to theoretical plate)
7. Study of fluidized bed dying
8. Study of steam distillation
9. Studies on gas-liquid-solid reaction using hydrodynamic cavitation- carbonization process.
10. Polymerization of acrylic acid in a batch reactor.
11. Demonstration of nitration reaction in Micro reactors
12. Demonstration of Microwave Reactor
13. Demonstration of Ultrasound Probe Reactor
14. Kinetic studies using Dilatometer.

Process Control and Instrumentation Laboratory **01 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	**25UD1527PCL609**	**Process Control and Instrumentation Lab**	**-**	**-**	**2**					**01**

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Calculate the characteristics of control valves
CO2: Determine the dynamics of level and temperature measurement process
CO3: Determine the dynamics of two capacity liquid level process without interaction and with interaction, U-tube manometer.
CO4: Determine the performance of controllers for a flow process, pressure process, level process, temperature process.
CO5: Evaluate the performance of cascade control

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓		✓			✓		✓	
CO2	✓			✓		✓			✓		✓	
CO3	✓			✓		✓			✓		✓	
CO4	✓			✓		✓			✓		✓	
CO5	✓					✓			✓		✓	

List of Experiments:

1. To determine the time constant of given thermometer with positive step change.
2. To determine the time constant of given thermometer with negative step change.
3. To determine the time constant and valve properties of single tank system.
4. To study the step response of two tank non-interacting liquid level system and compare the observed transient response with the theoretical transient response.
5. To study the step response of two tank interacting liquid level system and compare the observed transient response with the theoretical transient response for the condition T1=T2=T.
6. To study the impulse response of a tank.

Seminar II **01 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC Internship	**25UD1527JC610**	**Seminar-II**	**-**	**-**	**2**					**01**

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Acquire knowledge on topics outside the scope of curriculum.

CO2: Communicate with group of people on different topic

CO3: Collect and consolidate required information on a topic

CO4: Prepare a seminar report

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	✓
CO2	✓	✓	-	-	✓	✓	-	-	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	-	✓	-	-	-	✓	✓
CO4	✓	✓	-	✓	-	✓	✓	-	-	-	✓	✓

Each student is expected to collect information on recent advances in Chemical Engineering by regularly referring to national and international journals and reference books. At the end of the semester he/she is required prepare a report as per the guide lines prescribed by the Department. Each student will be assigned a guide for this seminar course.
Every student shall give a power point presentation on his Seminar topic before a panel of examiners.

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of fourth semester (during summer vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc.

The student shall submit the report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and appropriate grade shall be awarded.