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. Final Year Petrochemical

In line with National Education Policy 2020

With effect from AY 2024-2025

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 (up to 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 – VII

Sr. No.	Course Code	Subject Title	Contact Hours			Credits	Category
			L	T	P		
1	26UD1527PC701	Transport Phenomenon	3	-	-	3	PCC
2	26UD1527PC702	Process Equipment Design and Drawing	3	-	-	3	PCC
3	26UD1527PC703	Engineering Economics & Project Management	3	-	-	3	HSSM
4	26UD1527PC704	Advance Petroleum Refining	3	-	-	3	PCC
5	26UD1527PE705	PEC IV A) Natural Gas Technology B) Optimization Techniques in Chemical Engg. C) Introduction to Polymer Science and Technology	3	-	-	3	PEC
6	26UD1527MD706	MDM V (Petrochemical Technology)	2	-	-	2	MDM
7	26UD1527PCL707	Process Design, Flow Sheeting and Simulation Laboratory	-	-	2	1	PCC
8	26UD1527PCL708	Petrochemical Synthesis Laboratory			2	1	
9	26UD1527MP709	Mini Project	-	-	4	2	Project
10	26UD1527FT710	Industrial Training-II Evaluation (Assessment PP or NP grades)	-	-	-	-	
		Total	**17**	**-**	**8**	**21**	

**** Refer to Multidisciplinary Minor Bucket**

SEMESTER – VIII

Sr. No.	Course Code	Subject Title	Contact Hours			Credits	Category
			L	T	P		
1	26UD1527PE801	PEC V A) Pollution Control in Process Industries B) Research Methodology C) Entrepreneurship Development	2	-	-	3	PEC
2	26UD1527PE802	PEC VI A) Green Hydrogen Production B) Advanced Separation Processes C) Biomass & Biofuel Technology	2	-	-	2	PEC
3	26UD1527MD803	MDM VI (Utilities and Safety in Chemical Industry)	2	-	-	2	MDM
4	26UD1527PR804 / 26UD1527IN804	Project/ Internship	-	-	24	12	Internship/ OJT
		Total	**6**		**24**	**19**	

**** Refer to Multidisciplinary Minor Bucket**

SEMESTER – VII

Transport Phenomenon **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1527PC701	Transport Phenomenon	3	-	-	20	20	60	100	03

Course Outcomes:

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

CO1: Understand the analogy among momentum, heat and mass transport.
CO2: Formulate a mathematical representation of a flow/heat/mass transfer phenomena & Solve flow/heat/mass transfer problems either individually or coupled for simple geometries analytically
CO3: Identify the similarities among the correlations for flow, heat and mass transfer Interfaces.
CO4: Create original solutions to fluid flow, heat transfer and mass transfer problems and solve problems combining these transport phenomena.

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
Viscosity and Mechanism of Momentum Transport: Newton's Law of Viscosity; Non- Newtonian fluids; The Bingham model; the power law model; The Elli's model and the Reiner Philipp off model; Temperature and pressure dependents of viscosity.
Velocity Distributions in Laminar Flow: Shell momentum balances; Boundary conditions; Flow of a falling film; flow through a circular tube; flow through annulus.
Velocity Distributions with more than One independent variable Unsteady viscous flow;
Flow near a wall suddenly set in motion.

Unit II
Thermal Conductivity and Mechanism of Energy Transport: Fourier's law of heat conduction, temperature and pressure dependence of thermal conductivity in gases and liquids. Temperature Distributions in Solids and in Laminar Flow: Shell energy balances; Boundary conditions; Heat conduction with an electrical heat source; with a viscous heat source.
Temperature Distributions with more than One Independent Variable: Unsteady heat conduction in solids; Heating of a semi-infinite slab.

Unit III
Equation of Change for Isothermal Systems: Equations of continuity and motion in Cartesian and curvilinear co-ordinates; Use of the equations of change to set-up steady flow problems. Tangential annular flow of Newtonian fluid; Shape of surface of a rotating liquid
Interphase Transport in Isothermal Systems: Definition of friction factors; Friction factors for flow in tubes; for around spheres.

Equations of Change for Non-Isothermal Systems: Use of equations of energy and equations of motion (for forced and free convection) in non-isothermal flow; Tangential flow in anannulus with viscous heat generation; steady flow of a non-isothermal film; Transpiration cooling.

Unit IV

Interphase Transport in Non-Isothermal Systems: Definition of heat transfer coefficient; Heat transfer coefficients for forced convection in tubes; for forced convection around submerged objects.
Diffusivity and the Mechanism of Mass Transport: Definition of concentrations, Velocity and mass fluxes, Fick's law of diffusion, Temperature and pressure, dependence of mass diffusivity.
Concentration Distribution in Solids and in Laminar Flow: Shell mass balances; Boundary conditions; Diffusion through a stagnant gas film; Diffusion with heterogeneous chemical reaction.

Unit V

Equation of Change for Multicomponent Systems: Equations of continuity for a binary mixture.
Interphase Transport in Multicomponent Systems: Definition of binary mass transfer coefficients in one phase. Correlations of binary mass transfer coefficient in one phase at low mass transfer rates

Texts /References:

1. Bird R.B., Stewart W.E. and Light Foot E.N. Transport Phenomena – John Wiley International – 2nd Edition, New York, (2002).
2. Christie J. Geankoplis – Transport Processes and Unit Operations – Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

Process Equipment Design and Drawing 03 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1527PC702	Process Equipment Design and Drawing	3	-	-	20	20	60	100	03

Course Outcomes:

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

CO1: Identify equipment and instruments based on symbols
CO2: Draw process flow diagrams using symbols
CO3: Apply mechanical design aspects to process equipment
CO4: Design heat exchangers, evaporators, absorbers, distillation columns, reactors and filters.

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

Basic considerations in process equipment design; Materials and protective coatings; Analysis of stresses due to static loads, thermal effects, bending and deflection; Stresses in cylinders and spheres;

Materials of construction, Corrosion; Combined stresses, Theories of failure, Economic considerations

Unit II
Design of cylindrical and spherical vessels under internal pressure, Design of heads and closers; Design of tall vessels; Design of pressure vessels; Design of storage vessels for non-volatile and volatile liquids and gases

Unit III
Drawing of process equipment symbols for unit operations such as: fluid handling, heat transfer, mass transfer, conveyers, feeders, separators, mixing, distillation, driers, evaporators, scrubbers, crystallizer, grinding, elutriation, magnetic separation, compressor, etc; Drawing of symbols for basic and combined instrumentations for flow, temperature, level, pressure, etc; Significance of symbols

Unit IV
Detailed drawing of equipment; Drawing of process flow diagram (PFD), Drawing of piping and instrumentation diagram (P&ID)

Unit V
Design of reaction vessel, Design of heat exchanger, Design of evaporator, Design of distillation equipment, Design of supports, Design of agitators

Texts / References:

1. Brownell L.E, Young E.H., Process Equipment Design, Wiley, 2009.
2. Bhattacharya B.C., Introduction to Chemical Equipment Design - Mechanical Aspects, CBS Publishers and Distributors, 2011.
3. Donald Kern, Process Heat Transfer, McGraw-Hill Education, 2017.
4. Treybal R.E., Mass Transfer Operations, McGraw-Hill Education, 2017.
5. Mahajani V.V. and Umarji S.B., Joshi's Process Equipment Design, Laxmi Publications, 2016.

Engineering Economics and Project Management **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
HSSMC	26UD1527PC703	Engineering Economics and Project Management	3	-	-	20	20	60	100	03

Course Outcomes:

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

CO1: Analyse alternative processes and equipment for manufacturing a product.
CO2: Design plant layout and engineering flow diagrams
CO3: Perform economic analysis related to process design.
CO4: Evaluate project profitability

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
Capital cost estimation in chemical industries, different methods of calculation of fixed costs. Capital Investment and working Capital.

Unit II
Time value of money, types of interest, investment costs, annuities, perpetuity and capitalized costs, discounted cash flow analysis

Unit III
Taxes and insurance, depreciation, amortization and obsolescence in chemical industries, types of depreciation methods, breakeven point analysis

Unit IV
Discussion on projects causes for time and cost overruns, project evaluation and assessment of project profitability, organization of project engineering.

Unit V
Optimum process design with examples, project development and commercialization, plant location and layout, selection of plant capacity
Project engineering management, project scheduling and its importance, use of CPM/PERT techniques

Texts / References:

1. M. S. Peters and K. D. Timmerhaus, "Plant Design Economics for Chemical Engineers", 5th Ed., McGraw-Hill, New York - 2003.
2. V. W. Uhl and A. W. Hawkins, "Technical Economics for Chemical Engineers", AIChE - 1971.
3. J. Moder and Philips, "Project Engineering with CPM and PERT", Rein Hold.

Advanced Petroleum Refining **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1527PC704	Advanced Petroleum Refining	3	-	-	20	20	60	100	03

Course Outcomes:

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

CO1: To understand secondary refining processes for light and middle distillates and to analyse the application of these for different refining scenarios
CO2: To understand and evaluate various residue processing schemes.
CO3: To apply the finishing processes to petroleum products for meeting the market Specifications in view of fuel quality and environmental regulations.
CO4: Evaluate and compare different processes

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

Coking and Thermal Processes: Types, properties and uses of petroleum coke, process description for delayed coking and fluid bed coking, case study problem.

Unit II

Catalytic Cracking: Fluidized bed catalytic cracking, New design of FCC units, cracking reactions, Coking of cracking catalyst, process variables, heat recovery, yield estimation, capital and operating cost, case study problem on catalytic cracker.

Catalytic Hydrocracking: Hydrocracking reactions, feed preparation, process description, hydrocracking catalyst, process variables, hydrocracking yield, investment and operating cost, case study problem on hydrocracker.

Unit III

Hydroprocessing and Resid processing: Composition of vacuum tower bottoms, process options, hydroprocessing, expanded bed hydrocracking processes, moving bed hydroprocessors, solvent extraction, summary of resid processing operations.

Hydrotreating: Hydrotreating catalyst, aromatic reduction, reactions, process variables, construction and operating cost, case study problem on hydrotreator.

Unit IV

Catalytic reforming and isomerization: Feed preparation, catalytic reforming processes, reforming catalysts, reactor design, yields and costs.

Isomerization: Capital and operating costs, isomerization yield, case study problem on Reformer and isomerization unit

Unit V

Alkylation and polymerization: Alkylation reactions, process variables, alkylation feed stocks, alkylation products, HF and sulfuric acid alkylation process, comparison between the processes, alkylation yields and costs, co-polymerization , case study problem on alkylation and polymerization.

Texts /References:

1. J.H. Gary, " Petroleum Refining - Technology and Economics" 3rd Ed., Marcel DekkarInc, 1994
2. G.D.Hobson, " Modern Petroleum Technology" Vol.I& II ,5th Ed., Applid science ,London

PEC IV

A) Natural Gas Technology 03 Credit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	26UD1527PE705	Natural Gas Technology	3	-	-	20	20	60	100	03

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

CO1: Understand composition of natural gas
CO2: Understand the processing of natural gas
CO3: Evaluate the economics of natural gas pricing
CO4: Understand natural gas hydrates and mechanism of their formation
CO5: Understand the technology for LNG

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

Natural Gas: Composition of natural gas, Energy content, statistics and pricing, natural gas and environment, deposits world and Indian scenario.

Unit II

Field operation of natural gas before transportation, Natural Gas processing, Storage and transport

Unit III

Sweetening of Natural gas, Relative merits and demerits of natural gas as a fuel, Uses of Natural gas

Unit IV

Possible future sources, Liquefied Natural Gas, Technology for LNG

Unit V

Chemicals from natural gas.

Text/ References

Gatez S.L .Hand book of Natural Gas Technology

B) Optimization Techniques in Chemical Engg. 03 Credit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1527PE705**	**Optimization Techniques in Chemical Engg.**	**3**	**-**	**-**	**20**	**20**	**60**	**100**	**03**

Course Outcomes

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

CO1: Formulate and solve linear Programming Problems.

CO2: Determine the optimum solution to constrained and unconstrained.

CO3: Apply dynamic programming principle to Linear programming problems.

CO4: Determine the integer solutions to Linear Programming Problems.

Mapping of Course Outcomes with Program Outcomes

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

Detailed Syllabus

Unit I

Single-variable optimization algorithms: Optimal problem formulation, Optimization algorithms, Optimality criteria, Bracketing methods, Region-elimination methods, Point-estimation method, Gradient based methods, Root finding using optimization techniques.

Unit II

Multi-variable optimization algorithms: Unidirectional search, Direct search methods, Gradient based methods.

Unit III

Constrained optimization algorithms: Kuhn-Tucker conditions, Transformation methods.

Unit IV

Sensitivity analysis: Direct search for constrained minimization, Linearized search techniques, Feasible direction method, Generalized reduced gradient method, Gradient projection method.

Unit V

Specialized algorithms: Integer programming, Geometric programming. Non-traditional optimization algorithms: Genetic algorithms, Simulated annealing, Global optimization.

Texts / References

1. Deb K., Optimization for Engineering Design, Algorithms and Examples, Prentice Hall of India, New Delhi 1996.

C) Introduction to Polymer Science and Technology 03 Credit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	26UD1527PE705	Introduction to Polymer Science and Technology	3	-	-	20	20	60	100	03

Course Outcomes:

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

CO1: Understand thermodynamics of polymer structures
CO2: Select polymerization reactor for a polymer product.
CO3: Characterize polymers.
CO4: State polymer additives, blends and composites.
CO5: Understand polymer rheology

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- Basic concepts of Polymer Science, Various molecular forces in polymer, Various Molecular weights and their distribution.

Unit II

Polymerization- Step growth: Mechanism, Kinetics, Polyfunctional Step growth polymerization. (ii) Radical polymerization: Mechanism, Kinetics, Effects of temperature, pressure. (iii) Ionic and Coordination Polymerization: Kinetics of Cationic and Anionic polymerization.

Unit III

Polymerization Conditions- Bulk, Solution, Suspension and Emulsion polymerization.

Unit IV

Measurement of Molecular Weight- End group analysis, Colligative property measurement, Gel Permeation Chromatography.

Unit V

Polymer Processing- Plastic technology: Molding, Extrusion, Additives and Compounding;
Fiber Technology- Textile and Fabric properties, Spinning, Elastomer technology: Vulcanization, Reinforcement.

Texts/References:

1. Text book of Polymer Science: Fred W. Billmeyer, Jr., Second Edition, 1994, John Wiley and Sons, Inc., Singapore.
2. Principals of Polymerization, George Odian, Third Edition, 2002, John Wiley and Sons, Inc., Singapore.
3. Fundamentals of Polymers, Anil Kumar and Gupta, R. K., McGraw Hill, 1998.

MDM V - Petrochemical Technology **02 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
MDM	**26UD1527MD706**	**Petrochemical Technology**	**2**	**-**	**-**	**20**	**20**	**60**	**100**	**02**

Detailed syllabus:

Unit I

Petrochemical Industry in India. Feedstock's for petrochemicals, Separation of aromatics

Unit II

Petrochemicals from refinery feedstock , Natural gas as a feedstock, α- olefins, cumene, maleic anhydride (MAN), propylene oxide, isoprene, linear alkyl benzene, Petrochemical linkage with GDP, socio economic linkage

Unit III

Chemistry and principles of polymerization. Theory of polymerization. Manufacture of Thermoplastics : Polyethylene, Polyvinyl chloride, polystyrene

Unit IV

Thermosetting Resins : UF, PF, MF resins

Unit V

Fibers : Detailed process description with flow diagram for manufacture of polyester, and polyamides. Acrylic fibers – a brief exposure.

Text Books:

1. G. N. Sarkar : Advanced Petrochemicals, Khanna Publishers Delhi First edition 2016

2. B.K. Bhaskararao : A text on Petrochemicals , Khanna Publishers Delhi First edition 2015

3. I. D. Mall : Petrochemical Process Technology , Macmillan India ltd, 2007

4. Brydson : Plastic Materials , Elsevier Publication , Seventh edition

Process Design, Flow Sheeting & Simulation I Lab **01 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	26UD1527PCl707	Process Design, Flow Sheeting & Simulation I Lab	-	-	2					01

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

CO1 Identify equipment and instruments based on symbols
CO2 Draw process flow diagrams using symbols
CO3 Apply mechanical design aspects to process equipment
CO4 Design heat exchangers, evaporators, absorbers, distillation columns, reactors and filters.

Mapping of course outcomes with program outcomes

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

Process Design, Flow Sheeting & Simulation Laboratory (BTCHl708)

List of Practical's:
1. Simulation of a Flash Drum.
2. T-xy and P-xy Diagrams of a Binary Mixture.
3. Computation of Bubble Point Temperature.
4. Simulation of Mixer, Heat Exchanger and a Flash Drum.
5. Simulation of a RStoic Model, RCSTR Model & RPlug Model.
6. Simulation of RCSTR Model & RPlug Model.
7. Simulation of a DSTWU Model.
8. Aspen plus Simulation of the Binary Distillations Columns.
9. Aspen Plus Simulations of the Binary Distillations Columns using Distl. Model.
10. Simulation and Analysis of an Absorption Column.
11. Simulation of a Stripping Column.

Petrochemical Synthesis Laboratory **02 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
	26UD1527PCL708	**Petrochemical Synthesis Laboratory**	**-**	**-**	**4**	**-**	**-**	**-**	**-**	**02**

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

CO1: Understand details of synthesis process
CO2: Evaluate the quality of synthesized product
CO3: Apply knowledge for analysis of experiments
CO4: Compare product synthesis by different routes

Mapping of Course Outcomes with Program Outcomes

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

List of Experiments
1. Preparation of adipic acid
2. Preparation of aspirin
3. Preparation of nitrobenzene
4. Preparation of aniline by Bechamp reduction
5. Preparation of soap from fat
6. Preparation of nitrobenzene
7. Preparation of acetanilide
8. Preparation of methyl salicylate
9. Synthesis of biodiesel
10. Re-refining of used lubricating oil
11. Synthesis of bio-ethanol

Mini Project:

Mini Project II **02 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Project	**26UD1527MP709**	**Mini Project–II**	**-**	**-**	**4**	**60**	**-**	**40**	**100**	**02**

The purpose behind the mini project is that the student should be exposed to more hands-on rather than merely theory. It is expected that the student (or a small group say, not more than two in a group, to be confirmed) will undertake to make a working model, a program, etc. which he/she will benefit from since he /she will be doing it first-hand.

Industrial Training Evaluation (Assessment PP or NP grades): **Audit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit

Internship	**26UD1527FT710**	**Industrial Training-II Evaluation (Assessment PP or NP grades)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**Audit**

Course Outcomes:

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

CO1: Acquire knowledge on topics outside the scope of curriculum on summer training.
CO2: Communicate with group of people on different topics of summer training.
CO3: Collect and consolidate required information on a topic of summer training.
CO4: Prepare a seminar report on summer 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 sixth 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.

SEMESTER – VIII

PEC V

A) Pollution Control in Process Industries **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	26UD1527PE801	Pollution Control in Process Industries	2	-	-	20	20	60	100	03

Course Outcomes:

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

CO1: Analyse the effects of pollutants on the environment
CO2: Understand meteorological aspects of air pollution
CO3: Understand air pollution control methods
CO4: Select treatment technologies for water/wastewater/solid waste
CO5: Design unit operations for pollution 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	✓	✓	✓	✓	-	-	✓	-	-	-	-	-

Detailed Syllabus:

Unit I

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil.

Air pollution sources and effects: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise.

Unit II

Air pollution sampling and measurement: Types of pollutant sampling and measurement, Ambient air sampling, Stack sampling, Analysis of air pollutants.

Air pollution control methods & equipment: Control methods, Source correction methods, cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment.

Unit III

Control of specific gaseous pollutants: Control of sulphur dioxide emissions, Control of nitrogen oxides, Carbon monoxide control, Control of hydrocarbons and mobile sources. Water pollution: Water resources, Origin of wastewater, types of water pollutants and there effects.

Unit IV

Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, Advanced wastewater treatment, Recovery of materials from process effluents.

Unit V

Solid waste management: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal. Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods.

Text / References:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India 1993.
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, 2004.
4. Rao M.N. and Rao H.V.N - Air Pollution, Tata - McGraw Hill Publishing Ltd., 1993.

B) Research Methodology **03 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	26UD1527PE801	Research Methodology	2	-	-	20	20	60	100	03

Course Objectives:

1. To Understand the concept of research, paper writing, similarities, etc
2. To familiarize the students about the statistical methods, data interpretation , error analysis
3. To carry out analysis on the a published paper

Course Outcomes:

At the end of the program the student will be able to:

CO1: Understand and Describe importance of research.
CO2: Classify and select appropriate resources for Research.
CO3: Analyse the contents of literature and identify further scope.
CO4: Formulate a Research Problem.
CO5: Develop effective written and oral Presentation skills.

Mapping of COs with POs:

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

Detailed syllabus:

Unit I

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit II

Research process – Criteria for good research – Problems in Indian context. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit III

Hypothetical proposals for future development and testing, selection of Research task.

Unit IV

Mathematical modelling and simulation – Concepts of modelling – Classification of
Mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

Unit V

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation- Significance of report writing – Different steps inreport writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.
Applications of statistical methods in research

Texts/ References:

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

C) Entrepreneurship Development 03 Credit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	26UD1527PE801	Entrepreneurship Development	2	-	-	20	20	60	100	03

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

CO1: Understand entrepreneurship and entrepreneurial process and its significance in economic development.

CO2: Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.

CO3: Identify entrepreneurial opportunities, suppose a new venture within legal and formal frame work and resource requirements to launch.

CO4: Develop a framework for technical, economic and financial feasibility.

CO5: Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.

CO6: Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

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:
Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Unit II:
Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Unit III:
Planning a Small Scale Enterprises: Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Unit IV:
Operational Issues in SSE: Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and
industrial Laws.

Unit V:
Performance appraisal and growth strategies: Management performance assessment and control, Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:
1. G.G. Meredith, R.E. Nelson and P. A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.

PEC VI

A) Green Hydrogen Production **02 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1527PE802**	**Green Hydrogen Production**	**2**	**-**	**-**	**20**	**20**	**60**	**100**	**02**

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

CO1: Understand the basic properties of hydrogen, including its chemical and physical characteristics, and its role as an energy carrier.
CO2: Select a suitable Green hydrogen generation and storage technique based on the mechanisms, performance characteristics, and applicability.
CO3: Understand the safety considerations and regulations related to hydrogen handling.
CO4: Analyse the economic viability and environmental impact of hydrogen generation and storage systems.

Detailed Syllabus:

Unit I
Introduction: Basic Properties of Hydrogen, Engineering Thermodynamics, Hydrogen and Environment, Hydrogen and Sustainability, Hydrogen Production Methods, Green Hydrogen Sources, Hydrogen as an Energy Carrier, Historical Background and Current Applications.

Unit II
Fundamentals of Green Hydrogen Production: Definition and characteristics of green hydrogen, Electrolysis basics: water electrolysis and electrolyzer technologies, Renewable energy integration: solar, wind, and hydro power

Unit III
Electrolysis Technologies: Alkaline electrolysis, Proton exchange membrane (PEM) electrolysis, Solid oxide electrolysis cells (SOEC), High-temperature electrolysis , Photoelectrochemical (PEC) hydrogen production, Bioelectrochemical systems (BES)

Unit IV
Hydrogen Storage Techniques: Compressed Gas Storage, Liquid Hydrogen Storage, Chemical Storage (hydrogenation, metal hydrides), Physical Storage Using Nanostructured and Porous Materials, Underground Hydrogen Storage, Emerging Hydrogen Storage Technologies.

Unit V
Safety and Regulations: Safety Considerations in Hydrogen Handling and Storage, Codes and Standards for Hydrogen Storage Systems, Risk Assessment and Mitigation Strategies, Carbon footprint of green hydrogen, Market trends and future projections

Text Books:

1. Hydrogen Generation, Storage and Utilization, Zhang, J. Z., Li, J., Li, Y., Zhao, Y., John Wiley & Sons, 2014.
2. Sustainable Hydrogen Production, Dinçer, I., Zamfirescu, C., Elsevier, 2016.
3. Advances in Hydrogen Production, Storage and Distribution, Iulianelli, A., Basile, A., Elsevier, 2014.
4. Renewable Hydrogen Technologies: Production, Purification, Storage, Applications and Safety" by Luis M. Gandia

B) Advanced Separation Processes **02 Credit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1527PE802**	**Advanced Separation Processes**	**2**	**-**	**-**					**02**

Course Objectives:

1. Learn novel separation techniques
2. Research potential commercial applications
3. Learn how to estimates the separation parameter

Course Outcomes:

At the end of successful completion of the course the student will be able to:

CO1: Understanding of new developments in separation methods.
CO2: Ability to distinguish between various chemical substances
CO3: Being able to use various advanced tools.
CO4: Knowledge of the main topic that is significantly more in-depth
CO5: Greater understanding of experimental techniques
CO6: Apply of the manufacturing techniques used in the separation procedure

Detailed Syllabus:

Unit I
Ultra filtration, Micro filtration, Nano filtration

Unit II
Reverse Osmosis, Ion Exchange Pervaporation

Unit III
Pressure swing Adsorption, Gas Permeation

Unit IV
Electrostatics Precipitators, Dialysis and Electro-dialysis.
Unit V
Supported Liquid Membranes, Supercritical Fluid Extraction etc

C) Biomass & Biofuel Technology **02 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	**26UD1527PE802**	**Biomass & Biofuel Technology**	**2**	**-**	**-**	**20**	**20**	**60**	**100**	**02**

Detailed Syllabus:

Unit I
Introduction to oil economy: working principle of IC engines, Effects of emissions of Greenhouse gases and other pollutants, National Biofuel Policy and law, Biomass to Biofuels:

Unit II
Biomass formation on the earth: photosynthesis; Chemistry and composition of Biomass. Biomass conversion technologies: Pre-treatment technologies, Biomass to liquid fuels. Biomass degrading enzymes and microorganisms.

Unit III

Bioethanol production from lignocellulosic feed stocks, algae and sea weeds. Genetic and metabolic engineering of bacteria and yeast for bioethanol production. Strain engineering for ethanol and inhibitor tolerance.

Unit IV

Vegetable oils and chemically processed biofuels: Biodiesel composition and production processes, Biodiesel economics, Fischer-Tropsch Diesel: Chemical Biomass–to–Liquid Fuel Transformations. Algae Biodiesel; Technical challenges in biodiesels production.

Unit V

Biomass to gaseous fuel production: Bio hydrogen Production, Microbial Fuel Cells. Concept of Bio refinery: Lignocellulose-Based Chemical Products.
Entrepreneurial Opportunities in Bioenergy.

Learning Resources:

Text Books:

1. Bioenergy Research: Advances and Applications,Vijai K. Gupta. Maria Tuohy. Christian Kubicek, Jack Saddler, Feng Xu, Elsevier B.V. Netherlands 119, 2014.
2. Bioenergy: biomass to biofuels,Dahiya, A. Elsevier, 2015.
3. Introduction to Bioenergy (Energy and the Environment), Vaughn C. Nelson, Kenneth L. Starcher, CRC Press, 2016

Reference Books:

1. Biofuel Technologies-Recent Developments,Vijai K. Gupta et al.,Springer-Verlag Berlin Heidelberg, Elsevier, 2013.
2. Metabolic Regulation and Metabolic Engineering for Biofuel and Biochemical Production, Kazuyuki Shimizu, CRC Press, 2017.
3. Biofuel-Biotechnology, Chemistry, and sustainable Development, David M. Mousdale, I Edition, CRC Press Taylor & Francis Group, 2008.
4. Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, Ayhan Demirbas, 1stedition, Springer, 2009.

MDM VI – (Utilities and Safety in Chemical Industry) 02 Credit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
MDM	26UD1527MD803	Utilities and Safety in Chemical Industry	2	-	-	20	20	60	100	02

Detailed syllabus:

Unit I

Identification of common plant utilities: water, compressed air, steam, vacuum, refrigeration, venting, flaring and pollution abating. Water and its quality, storage and distribution for cooling and firefighting.
Steam generation by boilers: Types of boilers and their operation, Steam generation by utilizing process waste heat using thermic fluids, Distribution of steam in a plant.

Unit II

Principles of refrigeration: Creation of low temperature using various refrigerants. Creation of low pressure/vacuum by pumps and ejectors.

Unit III

Safety in Chemical Processes: Introduction, Chemical Process classification, Process design and safety parameters.

Chemicals and their Hazards: Introduction, Acetonitrile, acetyl chloride, butyl amine, acrylamide, acrylonitrile, allyl alcohol, benzene, bromine, isopropyl alcohol, acetaldehyde, ethylene oxide, butane, n-hexane, anhydrous ammonia, acetone, toluene, p-xylene, acetic acid, monochloro benzene, oleum, carbon monoxide.

Unit IV

Hazards in Chemical Process plants: Introduction, Hazards, Hazard code and explosive limit, electrical safety in chemical process plants, static electricity hazards, pressure vessel hazards, LEL and UEL of various compounds, explosive hazard, flammable liquid hazards, protection to storage tanks, fire zone location, fireball, fireball hazard.

Unit V

Combating Chemical Fires: Classification of fires, control of high vaour pressure fire, firefighting foams, foam for fire protection, Foam characteristics, gaseous agent extinguishing system, automatic sprinkler system, chemical extinguishing powders, natural gas fire control. Portable fire extinguishers: Soda-acid extinguishers, carbon dioxide extinguisher, dry chemical fire extinguisher, general safety precautions for maintenance of fire extinguishers.

Safety Checklist: safety studies for chemical plants, safety checklist during startup, safety checklist during shutdown mode, safety checklist for installation, safety needs during construction. Protective devices.

Text Books:

1. S. D. Dawande, Chemical Hazards and safety, Dennet& Co publishers, 2

Project/Internship **12 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Project/ Internship	**26UD1527PR804 / 26UD1527IN804**	**Project work / Internship**	**-**	**-**	**24**	**60**	**-**	**40**	**100**	**12**

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 topics.
CO3: Collect and consolidate required information on a topic.
CO4: Prepare a seminar report and present

Mapping of course outcomes with program outcomes

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

Every student will have to do Project Work or Internship for the whole semester. The student can choose area suitable to him/her and should devote full semester for the project work or internship assigned to him/her either in industry or research institution. The work will be continuously monitored by the Guide/s assigned to him/her. The student has to prepare/submit reports and do presentations as per the rules framed by the University/department from time to time.