Dr. Babasaheb Ambedkar Technological University, Lonere

(Established as a University of Technology in the State of Maharashtra)

(Under Maharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra

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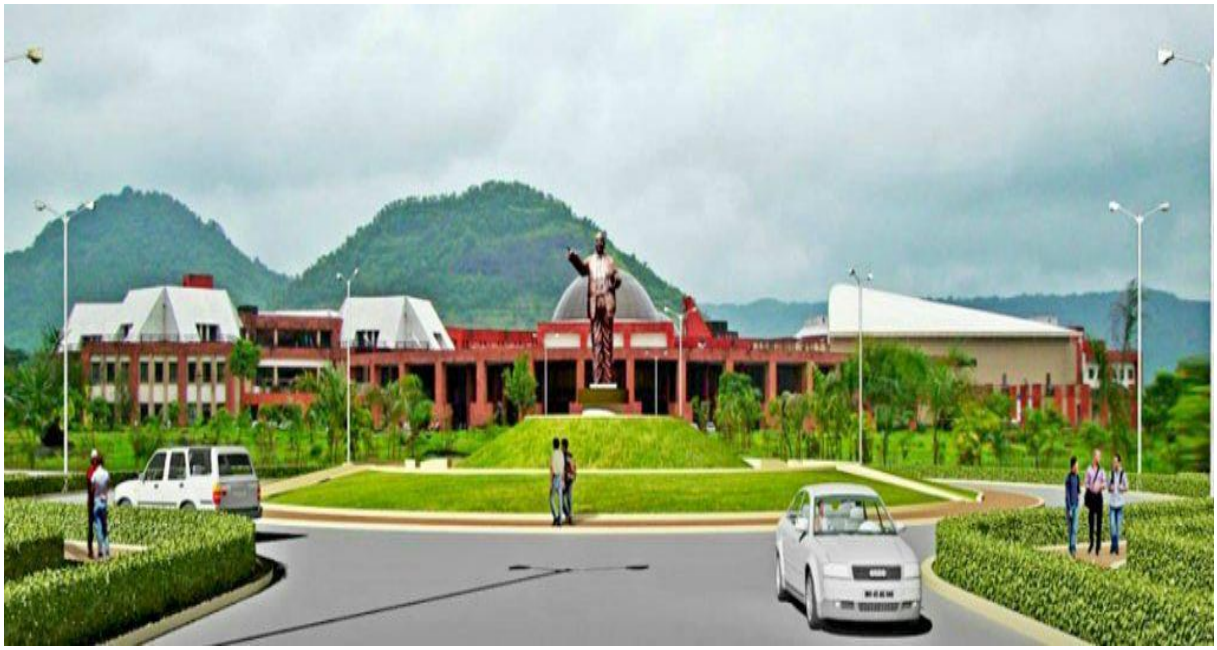
Curriculum for Final Year
Undergraduate Degree Programme
B. Tech. in Petrochemical Engineering

With effect from AY 2023-2024



Dr. Babasaheb Ambedkar Technological University

Lonere 402 103, Dist- Raigad, Maharashtra, INDIA

Rules and Regulations

1. The normal duration of the course leading to B. Tech. degree will be EIGHT semesters.
2. The normal duration of the course leading to M. Tech. degree will be FOUR semesters.
3. 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.
4. 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.
5. 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 the 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. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.
4. 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 fulfills the following conditions:

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

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

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

   (d) 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 implementeds from academic year 2019-20,starting 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 awdared based on CGPA of all eight semester of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPAupto<5.50	Pass class
CGPA ≥ 5.50 &<6.00	SecondClass
CGPA ≥ 6.00 &<7.50	First Class
CGPA ≥ 7.50	Distinction
[Percentage of Marks =CGPA*10.0]	

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

1.	Mid-Semester Exam (MSE) Marks	20
2.	Continuous Assesment Marks	20
3.	End Semester Examination (ESE) Marks	60

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

1.	Continuous Assesment 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, 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 2019-2020.

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:

1. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(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:

$$SGPA = \frac{\left(\sum_{i=1}^{n} c_i g_i\right)}{\left(\sum_{i=1}^{n} c_i\right)}$$

Where

'n' is the number of subjects for the semester,

'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 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:

$$CGPA = \frac{\left(\sum_{i=1}^{m} c_i g_i\right)}{\left(\sum_{i=1}^{m} c_i\right)}$$

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.

Award of Degree of Honours

Major Degree

The concept of Major and Minors at B. Tech. level is introduced, to enhance learning skills of students, acquisition of additional knowledge in domains other than the discipline being pursued by the student, to make the students better employable with additional knowledge and encourage students to pursue cross-discipline research.

A. Eligibility Criteria for Majors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for majors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional advanced courses from the same discipline specified in the curriculum. These five courses should be of 4 credits each amounting to 20 credits. The students should complete these credits before the end of last semester.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded B. Tech. (Honours) Degree.

B. Eligibility Criteria for Minors

1. The student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for minors has to register at the beginning of 5th Semester
3. The student has to complete 5 additional courses from other discipline of their interest, which are specified in the respective discipline. These five courses should be of 4 credits each amounting to 20 credits.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (If the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded with B. Tech. Degree in ------- Engineering with Minor in ------ --Engineering.

(For e.g.: B. Tech. in Chemical Engineering with Minor in Computer Engineering)

For applying for Honors and Minor Degree the student has to register themselves through the proper system.

ATTENDANCE REQUIREMENTS:

1. All students must attend every lecture, tutorial, and practical classes.
2. To account for approved leave of absence (e.g. 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%.
3. 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.

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

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.

Dr. Babasaheb Ambedkar Technological University, Lonere-402103

Department of Petrochemical Engineering: Bachelor of Technology in Petrochemical Engineering

Subject Code	Subject	Credit Scheme
Basic Science Course (BSC)		
BTBS101	Engineering Mathematics I	(3-1-0) 4
BTBS102	Engineering Physics I	(3-1-0) 4
BTBS107L	Engineering Physics Lab	(0-0-2) 1
BTBS201	Engineering Mathematics II	(3-1-0) 4
BTBS202	Engineering Chemistry	(3-1-0) 4
BTBS207L	Engineering Chemistry Lab	(0-0-2) 1
BTBS301	Engineering Mathematics III	(3-1-0) 4
Engineering Science Course (ESC)		
BTES103	Engineering Graphics	(2-0-0) 2
BTES105	Energy and Environmental Engineering	(2-0-0) 2
BTES106	Basic Civil and Mechanical Engineering	(2-0-0) 2
BTES108L	Engineering Graphics Lab	(0-0-4) 2
BTES203	Engineering Mechanics	(2-1-0) 3
BTES204	Computer Programming	(3-0-0) 3
BTES205	Workshop Practice	(0-0-4) 2
BTES206	Basic Electrical and Electronics Engineering	(2-0-0) audit
BTES207L	Engineering Chemistry Lab	(0-0-2) 1
BTES208L	Engineering Mechanics Lab	(0-0-2) 1
Humanities and Social Sciences including Management Course (HSSMC)		
BTHM104	Communication Skills	(2-0-0) 2
BTHM109L	Communication Skills Lab	(0-0-2) 1
BTHM403	Basic Human Rights	(3-0-0) 3
BTHM604	Process Economics and Industrial Management	(4-0-0) 4
Professional Core Courses (PCC)		
BTPCC302	Unit Operations – I	(3-1-0) 4
BTPCC303	Stoichiometry	(3-1-0) 4
BTPCC304	Petrochemical Engg.-I	(4-0-0) 4
BTPCL305	Petrochemical Engg. Lab.	(0-0-3) 2
BTPCL306	Unit Operations- I Lab.	(0-0-3) 2
BTPCC401	Chemical Engineering Thermodynamics	(4-1-0) 5
BTPCC402	Unit Operations –II	(3-1-0) 4
BTPCC404	Petrochemical Engg. –II	(3-1-0) 4
BTPCL406	Unit Operations –II Lab	(0-0-3) 2
BTPCC501	Mass Transfer – I	(3-1-0) 4
BTPCC502	Reaction Engineering – I	(3-1-0) 4
BTPCC503	Petrochemical Technology	(3-1-0) 4
BTPCL506	Reaction Engineering Lab.	(0-0-3) 2

Subject Code	Subject	Credit Scheme
Professional Core Courses (PCC)		
BTPCC601	Reaction Engineering II	(3-1-0) 4
BTPCC602	Mass Transfer – II	(3-1-0) 4
BTPCC603	Process Dynamics and Control	(3-1-0) 4
BTPCL606	Mass Transfer Lab.	(0-0-3) 2
BTPCC701	Transport Phenomena	(3-1-0) 4
BTPCC702	Process Equipment Design and Drawing	(3-2-0) 5
BTPCL705	Process Control and Process Simulation Lab.	(0-0-3)2
BTPCL706	Petrochemical Synthesis Lab	(0-0-3) 2
Professional Elective Courses (PEC)		
BTPCPE405A	Environmentally Sustainable Technology	(3-0-0) 3
BTPCPE405B	Fundamentals of Nanotechnology	(3-0-0) 3
BTPCPE405C	Numerical Method for Chemical Engineering	(3-0-0) 3
BTPCPE405D	Introduction to Material Science	(3-0-0) 3
BTPCPE405E	Advanced Engineering Chemistry	(3-0-0) 3
BTPCPE505A	Natural Gas Technology	(3-0-0) 3
BTPCPE505B	Membrane Technology	(3-0-0)3
BTPCPE505C	Design of Heat exchangers	(3-0-0) 3
BTPCPE505D	Process Plant Utilities and Safety	(3-0-0) 3
BTPCPE605A	Energy Management in Petrochemical Industry	(3-0-0)3
BTPCPE605B	Polymer Science and Technology	(3-0-3) 3
BTPCPE605C	Chemical Process Optimization	(3-0-0) 3
BTPCPE703A	Mathematical Methods in Chemical Engineering	(3-0-0) 3
BTPCPE703B	Catalyst Science and Technology	(3-0-0) 3
BTPCPE703C	Advance Petroleum Refining	(3-0-0) 3
BTPCPE703D	Novel Separation Processes	(3-0-0) 3
BTPCPE703E	Environmental Engineering	(3-0-0) 3
Open Elective Courses (OEC)		
BTPCOE504A	NSS-I	(3-0-0) 3
BTPCOE504B	Renewable Energy Sources	(3-0-0) 3
BTPCOE504C	Product Design Engineering	(3-0-0) 3
BTPCEO504D	Pharmaceuticals and Fine Chemicals	(3-0-0) 3
BTPCOE704A	NSS II	(3-0-0) 3
BTPCOE704B	Entrepreneurship Development	(3-0-0) 3
BTPCOE704C	Disaster Management in Chemical Industries	(3-0-0) 3
BTPCOE704D	Corporate Communication	(3-0-0) 3
BTPCOE704E	Pollution Control in Process Industries	(3-0-0) 3

Subject Code	Subject	Credit Scheme	Subject Code	Subject	Credit Scheme
Mini Projects			**Field Training/Internship**		
BTPCM507	Mini Project I	(0-0-4) 2	BTPCI308	Internship I (four weeks)	Audit
BTPCM607	Mini Project II	(0-0-4) 2	BTPCI508	Internship II (four weeks)	Audit
BTPCM707	Mini Project III	(0-0-4) 2	BTPCI708	Internship III (four weeks)	Audit
Seminar			**Project**		
BTPCS307	Seminar I	(0-0-4) 2	BTPCP/BTPCI 801	Project work/Internship (One semester duration)	(0-0-24) 12
BTPCS407	Seminar II	(0-0-4) 2			

Program Educational Objectives:

Objective Identifier	*Objectives*
PEO1	To provide a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems
PEO2	To impart rigorous training to students with good scientific and engineering breadth in core subjects so as to analyze , design and apply knowledge for development of novel products and create solutions for the real life problems
PEO3	To prepare students to excel in technical fields in order to pursue postgraduate programs or to succeed in industry/technical profession, R&D institutions through global and new emerging areas in chemical engineering
PEO4	To develop an ability to understand problems from other disciplines of science and engineering and provide solution by use of his professional skills.
PEO5	To impart skills necessary, as a professional, for adapting rapid changes taking place in the chemical and allied industries as well as getting ready for unconventional industries like software industry.
PEO6	To provide environment of knowledge and sense of responsibility towards ethical issues arising due to development of new technologies in the society on large scale.

Program Outcomes:

Outcome Identifier	Outcomes
PO1	The graduates will possess the knowledge of various discrete mathematical structures and numerical techniques.
PO2	The graduate will demonstrate the use of Logic in representing and reasoning knowledge-based systems.
PO3	The graduates will have an ability to apply mathematical formalisms of to analyze the problems.
PO4	The graduates will have knowledge of design software/s and concepts essential to implement this software/s.
PO5	The graduates will have an ability to analyze problem, specify most feasible solutions to them and to evaluate alternative solutions.
PO6	The graduates will have in-depth knowledge of core subjects of Chemical and Petrochemical Engineering.
PO7	The graduate will have broad understanding of the impact of Chemical and Petrochemical Engineering solutions in economic, environmental and social context.
PO8	The graduates will demonstrate use of analytical tools in gathering requirements to provide feasible solutions.
PO9	The graduates will have knowledge of design rules and patterns necessary to formulate concept-based solutions.
PO10	The graduates will demonstrate the ability to build human centric interfaces to design tools.
PO11	The graduates will possess the knowledge of advanced and emerging topics in the fields of Chemical and Petrochemical Engineering systems.
PO12	The graduates will posses skills necessary to communicate design engineering ideas. The skills set include verbal, written and listening skills.
Program Specific Objectives :	
PO13	The graduates will have an ability and attitude to address the ethical issues.
PO14	The graduates will demonstrate the ability to work and collaborate in heterogeneous teams.
PO15	The graduates will understand the role of Chemical and Petrochemical Engineering in realizing trouble shooting of operations.

	Semester VII									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				
			L	T	P	CA	MSE	ESE	Total	Credit
PCC 13	BTPCC701	Transport Phenomena	3	1	-	20	20	60	100	4
PCC 14	BTPCC702	Process Equipment Design and Drawing	3	2	-	20	20	60	100	5
PEC 4	BTPCPE703	Professional Elective – IV	3	-	-	20	20	60	100	3
OEC 2	BTPCOE704	Open Elective – II	3	-	-	20	20	60	100	3
LC	BTPCL705	Process Control and Process Simulation Laboratory	-	-	4	60	-	40	100	2
LC	BTPCL706	Petrochemical Synthesis Laboratory	-	-	3	60	-	40	100	2
Project	BTPCM707	Mini-Project – III	-	-	4	60	-	40	100	2
Internship	BTPCI708	Internship – 3 Evaluation	-	-	-	-	-	-	-	Audit
		Total	**12**	**3**	**11**	**260**	**80**	**360**	**700**	**21**
	Semester VIII									
Project/ Internship	BTPCP/ BTPCI – 801	Project work/ Internship	-	-	24	60	--	40	100	12
		Total	**-**	**-**	**24**	**60**		**40**	**100**	**12**

Total Credits for entire course structure = 18+19+22+23+22+23+21+12 = 160

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course, HSSMC = Humanities and Social Science including Management Courses

Professional Elective – IV

Sr. No.	Course Code	Course Name
01	BTPCPE703 A	Mathematical Methods in Chemical Engineering
02	BTPCPE703 B	Catalyst Science and Technology
03	BTPCPE703 C	Advanced Petroleum Refining
04	BTPCPE703 D	Novel Separation Processes
05	BTPCPE703 E	Environmental Engineering

Open Elective – II

Sr. No.	Course Code	Course Name
01	BTPCOE704 A	NSS II
02	BTPCOE704 B	Entrepreneurship Development
03	BTPCOE704 C	Disaster Management in Chemical Industries
04	BTPCOE704 D	Corporate Communication
05	BTPCOE704 E	Pollution Control in Process Industries

Semester VII

BTPCC701 Transport Phenomena 4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTPCC701	Transport Phenomena	3	1	-	20	20	60	100	4

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.

BTPCC702 Process Equipment Design and Drawing 5 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTPCC702	Process Equipment Design and Drawing	3	2	-	20	20	60	100	5

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.

BTPCPE703 Professional Elective – IV 3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	BTPCPE703	Professional Elective – IV	3	-	-	20	20	60	100	3

A. Mathematical Methods in Chemical Engineering

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

CO1	Formulate lumped and distributed parameter mathematical models for chemical processes.
CO2	Calculate degrees of freedom for the developed mathematical models.
CO3	Solve the model equations describing chemical processes and equipment
CO4	Analyze the results of the solution 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

Mathematical Formulation of the Physical Problems- Introduction, Representation of the problem, blending process, continuous stirred tank reactor, unsteady state operation, heat exchangers, distillation columns, biochemical reactors.

Unit II

Analytical (explicit) Solution of Ordinary Differential Equations encountered in Chemical Engineering Problems-Introduction, Order and degree, first order differential equations, second order differential equations, Linear differential equations, Simultaneous differential equations.

Unit III

Formulation of partial differential equations- Introduction, Interpretation of partial derivatives, Formulation partial differential equations, particular solutions of partial differential equations, Orthogonal functions, Method of separation of variables, The Laplace Transform method, Other transforms.

Unit IV

Unsteady state heat conduction in one dimension: Mass transfer with axial symmetry - Continuity equations; Boundary conditions - Iterative solution of algebraic equations- The difference operator - Properties of the difference operator- Linear finite difference equations.

Unit V:

Non-linear finite difference equations: Simultaneous linear differential equations - analytical solutions - Application of Statistical Methods.

Texts/References:

1. Rice R. G. and D. Do Duong, 'Applied mathematics and modeling for chemical engineers' John Wiley & Sons, 1995.
2. Jenson J F and G. V. Jeffereys, 'Mathematical Methods in Chemical Engineering', Academic Press, 1977.
3. B. A. Finlayson, 'Introduction to Chemical Engineering Computing', Wiley India Edition, 2010
4. Singaresu S. Rao, 'Applied Numerical Methods for Engineers and Scientists', Prentice Hall, 2002.
5. Amiya K. Jana, Chemical Process Modelling and Computer Simulation, Prentice Hall India, 2nd Edition, 2011.

B. Catalyst Science and Technology

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

CO1	Understand of various catalysts and the role of catalyst in chemical reactions.
CO2	Acquire knowledge of catalyst preparation and characterization methods.
CO3	Get knowledge of heat and mass transfer effects on catalytic reactions.
CO4	Design different types of reactors for conducting catalytic reactions.

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
Heterogeneous catalytic processes, types of heterogeneous reactions, absorption, absorption isotherms, rates of absorption, Physisorption and chemisorption, Solid catalysis, types of catalysts, catalyst formulations and Preparation methods

Unit II
Catalysts Characterization methods: Surface area and pore volume determinations, XRD, various Spectroscopic techniques, Temperature programmed reduction & oxidation, Electron microscopy.

Unit III
Testing of catalysts, various types of reactors, activity and selectivity studies. Effect of external transport processes on observed rate of reactions. Effect of internal transport processes: reactions and diffusion in porous catalysts.

Unit IV
Mechanism of catalytic reactions, Rates of adsorption, desorption, surface reactions, rate determining steps. Kinetic modeling and Parameter estimations, Model discriminations

Unit V
Catalysts promoters, Inhibitors, catalyst deactivations, kinetics of catalyst deactivations
Industrial processes involving heterogeneous solid catalysts. New development in solid catalysis, monolith catalysts, nanocatalysts, Fuel cell catalysts, Environmental catalysts, Design of catalysts; simulation techniques

Text /References:

1. G. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol. 1-5, Wiley - VCH.
2. B. Viswanathan, S. Sivasanker , A.V. Ramaswamy, "Catalysis : Principles & Applications" CRC Press.

3. J. M. Smith , "Chemical Engineering Kinetics" McGraw-Hill Book Company.
4. J. M. Thomas and W. J. Thomas, "Principles and Practice of Heterogeneous Catalysis", Wiley- VCH
5. H. S. Fogler, "Elements of Chemical reaction engineering" Prentice - Hall of India

C.Advanced Petroleum Refining

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 analyze 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

D. Novel Separation Processes

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

CO1	Explain different types of adsorptive separations and derive the equations for the same.
CO2	Design the chromatographic columns
CO3	Develop design equations for membrane separation processes such as RO&UF.
CO4	Explain concepts of surfactant based separations & physio-chemical aspects and applications of Super critical fluid extraction

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

Adsorption & Chromatography: Adsorptive separations: Review of fundamentals. Mathematical modeling of column factors. Pressure swing and thermal swing adsorption. Counter current separations, Chromatography: Chromatography fundamentals. Different types .Gradient & affinity chromatography. Design Calculations for chromatographic columns.

Unit II

Membrane Separation Processes: Thermodynamic considerations. Mass transfer considerations. Design of RO &UF. Ion selective membranes .Micro filtration, Electro dialysis Pervaporation. Gaseous separations

Unit III

Surfactant based & Super critical Separations: Surfactant based separations: Fundamentals. Surfactants at inter phases and inbulk. Liquid membrane permeation. Foam separations. Micellar separations.

Unit IV

Super critical fluid extraction: Thermodynamics and physicochemical principles. Process description, application, case study

Unit V

External Field Induced Separations: External field induced separations: Electric & magnetic field separations. Centrifugal separations and calculations. Other Separations: Separation by thermal diffusion, electrophoresis and crystallization

Texts / References:

1. Rousseu, R.W., Handbook of Separation Process Technology, John Wiley &Sons,2001
2. Seader.J.D., Separation Process Principles, John Wiley & Sons,3rd edition,2010
3. R. G. Gutman, "Membrane Filtration", Adam Hilger, Bristol, (1987).
4. R. Rautenbach, and R. Albercht, "Membrane Processes", John Wiley & Sons,(1994).
5. J. F. Scamehorn, and J. H. Harwell, "Surfactant Based Separation Processes", Surfactant Science Series, Vol. 33, Marcel – Dekkar Inc., New York, (1989).

E. Environmental Engineering

Course Outcomes: On completion of course, students will be able to:

CO1	Understand importance of environment and different types of pollution
CO2	Explain causes and preventive measures against air pollution
CO3	Describe causes and preventive measures against water pollution
CO4	Describe causes and preventive measures against soil and noise pollution

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

Air and Environment

1. Introduction: Man and Environment: Overview (socio-economic structure & occupational exposures) – Scope of Environmental Engineering – pollution problems due to urbanization & industrialization

2. Air Pollution: Causes of air pollution, types & sources of air pollutants, Climatic & Meteorological effect on air pollution concentration, formation of smog and fumigation

Analysis of Air Pollutants Collection of Gaseous Air Pollutants- Collection of Particulate Pollutants, Analysis of Air Pollutants like : Sulphur dioxide , Nitrogen oxide , Carbon monoxide, Oxidants and Ozone , Hydrocarbons , Particulate Matter

Unit II

Water and Environment

1.Water: Sources Origin of waste water , Types of water pollutants and their effects, different sources of water pollution, Biological Pollution (point & non-point sources) , Chemical Pollutants: Toxic Organic & Inorganic Chemicals , Oxygen demanding substances – Physical Pollutants: Thermal Waste , Radioactive waste , Physiological Pollutants: Taste affecting substances , other forming substances

2. Water Pollution & Its Control: Adverse effects on: Human Health & Environment, Aquatic life, Animal life, Plant life — Water Pollution Measurement Techniques – Water Pollution Control Equipments & Instruments – Indian Standards for Water Pollution Control

Unit III
Soil & Environment
1. Soil Polluting Agencies & Effect Of Solution Liquid & Solid Wastes : Domestic & Industrial Wastes – Pesticides – Toxic: Inorganic & Organic Pollutants – Soil Deterioration – Poor Fertility, Septicity, Ground Water Pollution, Concentration of Infecting Agents in Soil
2. Solid Waste Disposal: Dumping domestic & Industrial Solid Wastes: Advantages & Disadvantages – Incineration: Advantages & Disadvantages – Sanitary Land Field: Advantages & Disadvantages – Management of Careful & Sanitary Disposal of Solid Wastes

Unit IV
Noise and Environmental Management System
Noise Pollution: Intensity, Duration – Types of Industrial Noise, effects of Noise, Noise Measuring & Control, Permissible Noise Limits

Unit V
Environmental Legislations, Authorities and Systems
Air & Water Pollution Control Acts & Rules (Salient Features only) – Functions of State / Central Pollution Control Boards – Environmental Management System: ISO 14 000 (Salient Features only

Texts /References:

1. Rao C.S. - Environmental Pollution Control Engineering - Wiley Eastern Limited, India,1991
2. K. V. S. G. Murali Krishna – Air Pollution and Control – Kaushal and Co., 1999.
3. W. Wesley Eckenfelder Jr. – Industrial Water Pollution Control – McGraw Hill International, 1989.

BTPCOE704 Open Elective – II 3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
OEC	BTPCOE704	Open Elective- II	3	-	-	20	20	60	100	3

A. NSS – II

Course Outcomes: On completion of course, students will be able to:

CO1	Understand constitution of India and fundamental rights
CO2	Understand health, hygiene , sanitation and its importance
CO3	Have knowledge about Yoga and its philosophy
CO4	Know environmental issues, enrichment and sustainability
CO5	Understand disaster management and classification of disaster
CO6	Understand Sociological and psychological factors regarding youth and crime

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

Citizenship: Basic Features of Constitution of India, Fundamental Rights and Duties, Human Rights, Consumer awareness and the legal rights of the consumer, RTI.

Unit II

Health, Hygiene & Sanitation: Definition, Needs and scope of health education , Food and Nutrition , Safe drinking water, Water borne diseases and sanitation, National Health Programme, Reproductive health , Healthy Lifestyles ,HIV AIDS, Drugs and Substance abuse, Home Nursing , First Aid.

Unit III

Youth and Yoga: History, Philosophy and concept of Yoga , Myths and misconceptions about yoga , Different Yoga traditions and their Impacts, Yoga as a preventive, promotive and curative method, Yoga as a tool for healthy lifestyle.

Unit IV

Environment Issues: Environment conservation, Enrichment and Sustainability, Climate change, Waste management, Natural resource management, Rain water harvesting, Energy conservation, Waste land development, Soil conservations and forestation.

Unit V

Disaster Management: Introduction to Disaster Management, Classification disaster, Role of youth in Disaster Management. Youth and crime: Sociological and psychological factors influencing youth crime, Peer mentoring in preventing crime, Awareness about anti-ragging, Cybercrime and its prevention, Juvenile justice.

B. Entrepreneurship Development

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

CO1	Identify entrepreneurial opportunities, support and resource requirements to launch new venture within legal and formal frame work
CO2	Develop a framework for technical, economic and financial feasibility.
CO3	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO4	Strategies for Strategies for Stabilization and Growth of small scale enterprises.

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

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 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.

References:

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, Ahmadabad 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.

C. Disaster Management in Chemical Industries

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

CO1	Analyze the effects of release of toxic substances
CO2	Select the methods of prevention of fires and explosions
CO3	Understand the methods of hazard identification and preventive measures
CO4	Assess the risks using fault tree diagram

Mapping of course outcomes with program outcomes

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

Unit I:
General aspects of industrial disaster: Due to fire, explosion, toxicity and radiation; Chemical hazards.

Unit II:
Classification of chemical hazards, Chemical as cause of occupational diseases – dust, fumes, gases and vapours.

Unit III:
Hazard analysis and health management; Engineering control of chemical plant hazards – Plant layout, ventilation and lighting.

Unit IV
Pressure vessels, Storage, Handling, Transportation, Electrical systems, Instrumentation.

Unit V:
Emergency planning, Personal protective devices, Maintenance procedure; Emergency safety and laboratory safety; Legal aspects of safety. Management information system and its application in monitoring disaster, safety and health; Hazop Analysis.

Text Book:

1. H. H. Tawcatt & W S Wood, Safety and Accident Prevention in Chemical Operations.

Reference Books:

1. R. V. Betrabet and T. P. S. Rajan in CHEMTECH-I, Safety in Chemical Industry, Chemical
2. Engineering Development Centre, Madras, 1975.
3. Wells, Safety in Process Plant Design.
4. Less, P. Frank, Loss Prevention in Process Industries.
5. J. Lolb & S. Roy Sterm, Product Safety and Liability.

D. Corporate Communication

Course Outcomes: At the end of the course, students 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 corporate – 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. 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 III

Corporate responsibility: Circulating to employees' vision and mission statements- ethical practices- Human rights -Labor rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.

Unit IV

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.

Text / References:

1. Raymond V. Lesikar, John D. Pettit, Marie E. FlatleyLesikar's Basic Business Communication - 7th Edition: Irwin, 1993
2. Krishna Mohan and MeeraBanerji, 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.
5. Shirley Taylor, Communication for Business, Longman, 1999

E. Pollution Control in Process Industries

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.

BTPCL705 Process Control and Process Simulation Laboratory 2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
LC	**BTPCL705**	**Process Control and Process Simulation Laboratory**	**-**	**-**	**4**	**60**	**-**	**40**	**100**	**2**

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 $T_1=T_2=T$.
6. To study the impulse response of a tank.
7. General Concepts of Simulation for Process Design, Introduction to Process simulation models, Methods for solving non-linear equations, Recycle partitioning and tearing and Simulation examples.
8. Design of following equipment using ASPENPLUS or any design software
   a. Heat Exchanger
   b. Absorption column
   c. Distillation column
   d. Reactors
   e. Evaporator
   f. Flow sheeting of a chemical plant
   g. Simulation of a small size chemical plant

BTPCL706 Petrochemical Synthesis Laboratory 2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
LC	BTPCL706	Petrochemical Synthesis Laboratory	-	-	3	60	-	40	100	2

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

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

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 acetaanilide
8. Preparation of methyl salicylate
9. Synthesis of Biodiesel
10. Refining of used lubricating oil
11. Synthesis of bio-ethanol

BTPCM707 Mini Project III 2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Project	**BTPCM707**	**Mini Project– III**	**-**	**-**	**4**	**60**	**-**	**40**	**100**	**2**

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.

BTPCI708 Internship – 3 (Evaluation) Audit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Internship	**BTPCI708**	**Internship - 3 (Evaluation)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**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

BTPCP/ BTPCI – 801 Project/Internship 12 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Project/ Internship	**BTPCP/ BTPCI- 801**	**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.

Mapping of some courses with SWAYAM (NPTEL)

S. N.	Sem.	Name of the course	Name of equivalent NPTEL course	NPTEL Sem. (Even/ Odd)	Instructor's Name	Duration (weeks)	Syllabus content matching
1	III	Unit Operations -I	Fluid Flow Operations	Both	Prof. Subrato Kumar IIT Guwahati	33 lectures	50%
2		Stoichiometry	Basic Principles and Calculations in Chemical Engg.	Even	Prof. S. K. Majumdar IIT Guwahati	12	70%
3	IV	Engineering Thermodynamics	Chemical Engineering Thermodynamics	odd	Dr. Jayant K. Singh, IIT Kanpur	12	80%
4		Heat Transfer Operations	Heat Transfer	Even	Prof. Sunando Dasgupta IIT Kharagpur	12	75%
5		Unit Operations – II	Heat Transfer	Even	Prof. Ganesh Vishwanathan IIT Bombay	12	70%
6	V	Mass Transfer - I	Mass Transfer Operations I	Odd	Prof. Bishnupada Mandal IIT Guwahati	12	70%
7		Chemical Reaction Engineering I	Chemical Reaction Engineering I	Odd	Prof. Bishnupada Mandal IIT Guwahati	12	60%
8		PE III(Chemical Process Optimization)	Optimization in Chemical Engineering	Even	Prof. Debasis Sarkar IIT Kharagpur	12	75%
9	VI	Chemical Reaction Engineering II	Chemical Reaction Engineering II	Even	Prof. Ganesh Vishwanathan IIT Bombay	12	50%
10		Mass Transfer II	Mass Transfer Operations II	Odd	Prof. Chandan Das IIT Guwahati	12	50%
11		Process Dynamics and Control	Chemical process Control	Odd	Prof. Sujit Jogwar IIT Bombay	8	50%
12		Process Economics and	Plant Design and Economics	Odd	Prof. Debasis Sarkar	12	50%

		Industrial Management			IIT Bombay		
13	VII	Transport Phenomena	Transport Phenomena	Even	Prof. Sunando Dasgupta IIT Kharagpur	12	75%
14		Process Equipment Design and Drawing	Equipment Design: Mechanical aspects	Odd	Prof. Shabina Khanam IIT Roorkee	4	50%
15		Pollution Control in Process Industries	Basic Environmental Engineering and Pollution Abatement	Odd	Prof. P. Mondal IIT Roorkee	12	75%