Syllabus of

B. Tech. (Chemical Engineering)

(Overall Structure and Revised Syllabus w. e. f. 2018-19)

Faculty of Science and Technology

University Institute of Chemical Technology

Kavayitri Bahinabai Chaudhari

North Maharashtra University,

Jalgaon

Summary of Distribution of Credits under Academic Flexibility Scheme

for

B. Tech (Chemical Engineering)

at

UICT, KBCNMU, Jalgaon

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Sem VII	Sem VIII
01	Core	**15**	**15**	**17.5**	**18**	**18.5**	**14**	**15**	**-**
02	Skill based	**06**	**05**	**03**	**03**	**03**	**-**	**-**	**-**
03	Institute Elective	**-**	**-**	**-**	**-**	**03**	**06**	**03**	
04	Project	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**15**
05	Audit	**NC**	**NC**	**NC**	**-**	**NC**	**-**	**-**	**-**
06	Total Credits	**21**	**20**	**20.5**	**21**	**24.5**	**20**	**18**	**15**

Number of Audit Courses	**01**	**01**	**01**	**-**	**01**	**-**	**-**	**-**

Subject Type	Core	Skill based	Institute Elective	Project	Audit	Total
Credits	**113**	**20**	**12**	**15**	**NC**	**160**
Total Courses	**26**	**06**	**04**	**02**	**04**	**42**

Total Credits = 160, Total Courses = 42

Program at a Glance

Name of the program (Degree)	: B. Tech (Chemical Engineering)
Faculty	: Science & Technology
Duration of the Program	: FourYears (EightSemesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60 : 40 (60 Marks University Exam& 40 Marks Continuous Internal Departmental Exam/Assessment)
Passing Standards	: 40% in Each Exam separately for Theory courses and 50 % in Each Exam separately for Practical Courses. (Separate Head of Passing)
Evaluation Mode	: CGPA
Total Credits of the Program	: 160 [Core Credits :113]
	[Skill Based Credits :20]
	[Inst. Elective Credits :12]
	[Project Credits :15]
	[Audit Credits :NC]

Program Objectives (POb'S):

1. To impart basic engineering knowledge as well as capability of problem analysis.
2. To develop ability of investigation of complex problem and design/develop solution for their management.
3. To train the graduate for usage of modern tools in teaching - learning process
4. To develop ethics team spirit among the graduates.

Program Specific Objectives (PSOb'S):

PO No.	PO
PSO1	Inculcate the thought process for creative **analysis** and execution of fundamentals of basic sciences, unit operations and chemical processes.
PSO2	**Develop** the graduates with competitive skills to pursue career in academics, industries and innovative start-up.
PSO3	**Prepare** the professional Chemical Engineers with integrity and ethical values to become effective associate while addressing the social, moral, environmental and technically sustainable challenges.

Program Outcomes (PO'S):

Upon successful completion of the program, the graduate student will be able to:

PO No.	PO	Cognitive level
PO1	Apply knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.	3
PO2	Identify, formulate and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	1
PO3	Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	6
PO4	Using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	5
PO5	Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction&modelling tocomplex engineering activities with an under- standing of the limitations.	6
PO6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	3
PO7	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	2
PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	3
PO9	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	6
PO10	Communicate effectively on complex engineering activities with the engineering com- munity and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.	2
PO11	Demonstrate knowledge and understanding of Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments	2
PO12	Recognize need for &have preparation&ability to engage in independent and life- long learning in the broadest context of technological change.	6

B. Tech. (Chemical Engineering) Revised Syllabus w. e. f. 2018-19
(Overall Structure and Revised Syllabus w. e. f. 2018-19)

Semester-I (First Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
BSL-101	Mathematics-I	03	01	04	-	-	4.0
BSC-102	Physics	03	01	04	03	1.5	5.5
BSC-103	Chemistry-I	03	01	04	03	1.5	5.5
HMC-101	Communication Skills	02	-	02	02	01	3.0
ESC-101	Engineering Graphics	01	-	01	04	02	3.0
NC-101	Induction Program	-	-	-	-	NC	NC
						Total Credit	**21**

Semester-II (First Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
BSL-104	Mathematics-II	03	01	04	-	-	4.0
BSL-105	Thermodynamic-I	03	01	04	-	-	4.0
ESL-102	Electrical & Electronics Engineering	03	01	04	-	-	4.0
ESC-103	Computer Lab (Programming for problem solving)	03	-	03	04	02	5.0
ESL-104	Material Science &Technology	03	-	03	-	-	3.0
5555	Environmental Studies	-	-		-	NC	NC
						Total Credit	**20**

Semester-III (Second Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
BSC-206	Chemistry-II	03	01	04	03	1.5	5.5
ESL-205	Engineering and Solid Mechanics	03	01	04	-	-	4.0
CHL-201	Thermodynamics-II	03	01	04	-	-	4.0
ESC-206	Engineering Workshop	01	-	01	04	02	3.0
CHL-202	Transport Phenomena	03	01	04	-	-	4.0
NC-202	Constitution of India	-	-	-	-	NC	NC
						Total Credit	**20.5**

Semester-IV (Second Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-203	Heat Transfer	03	01	04	03	1.5	5.5
CHC-204	Fluid Mechanics	03	01	04	03	1.5	5.5
HML-202	Industrial Management and Economics	03	-	03	-		3.0
CHL-205	Chemical Process Technology	03	-	03	-	-	3.0
CHL-206	Material and Energy Balances Computations	03	01	04	-	-	4.0
						Total Credit	**21**

Semester-V (Third Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-307	Particle & Fluid ParticleProcessing	03	-	03	03	1.5	4.5
CHC-308	Mass Transfer-I	03	01	04	03	1.5	5.5
CHC-309	Chemical Reaction Engineering-I	03	01	04	03	1.5	5.5
HML-309	Psycho-Social Dimensions of Industrial Management	03	-	03	-	-	03
Elective-I	Open Elective	03	-	03	-	-	03
CHC-310	Numerical Method in Chemical Engineering	02	-	02	02	01	03
NC-303	Essence of Indian Traditional Knowledge	-	-		-	NC	NC
						Total Credit	**24.5**

Semester-VI (Third Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-311	Chemical Reaction Engineering-II	03	01	04	03	1.5	5.5
CHL-312	Process Design and Project Management	03	-	03	-	-	3.0
CHC-313	Mass Transfer-II	03	01	04	03	1.5	5.5
Open Elective	Elective-II	03	-	03	-	-	3.0
Professional Elective Courses	Elective-III	03	-	03	-	-	3.0
						Total Credit	**20.0**

Semester-VII (Fourth Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-414	Modelling, Simulation and CAD	03	01	04	03	1.5	5.5
CHL-415	Instrumentation & Instrumental Analysis	03	-	03	-	-	3.0
Elective-IV	Professional Elective Course	03	-	03	-	-	3.0
CHC-416	Process Dynamics & Control	03	-	03	03	1.5	4.5
CHC-417	Process Equipment Design & Drawing	01	-	01	02	01	2.0
						Total Credit	**18**

Semester-VIII (Fourth Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHP-418	Industrial Training/Project	-	-	-	24	12	12
CHP-419	Technical Seminar & Colloquium	-	-	-	06	03	03
						Total Credit	**15**

(NC = Non-Credit Course)

Total Credits (21+20+20.5+21+24.5+20+18+15) = **160**

Course Title: Mathematics- I

Course Code: BSL-101

Theory: 03Hrs. + 01 Tutorial/Week **Credits: 4.0**

Course Prerequisite:

The background expected includes a prior knowledge of mathematics from H.S.C. (Science) and familiarity with various principles and theorems.

Course Objectives:

The necessity for the foundation of Engineering and Technology being Mathematics, the main objective is to provide sufficient practice in the mathematical methods presented and develop mathematical skill and enhance thinking and decision-making power of student.

Unit –I: Linear Algebra

Elementary transformations on a matrix; Rank of a matrix; normal forms; Consistency and solutions of systems of linear equations; orthogonal matrix; Eigen values and Eigen vectors; Cayley-Hamilton's theorem (without proof). (10)

Unit –II: Differential Calculus and Its Applications

Successive differentiation – standard results; Leibnitz's theorem; Expansions of functions: Maclaurin's theorem, Taylor's theorem; Application of Taylor's theorem. (10)

Unit –III: Partial Differentiation

Partial derivatives of first and higher orders; Homogeneous functions – Euler's Theorem; Total derivatives; Change of variables. (10)

Unit –IV: Applications of Partial differentiations

Jacobians - properties; Errors and approximations; Maxima and minima of functions of two variables; Lagrange's method of undetermined multipliers for single constraints. (10)

Unit –V: Complex Numbers

Definition and geometrical representation; De-Moivre‟s theorem (without proof); Roots of

definition; Hyperbolic functions; Relations between circular and hyperbolic functions; Real and imaginary parts of circular and hyperbolic functions; Logarithm of Complex numbers. (10)

Text/Reference Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Eastern Ltd, 10th Edition.
2. B S Grewal, "Higher Engineering Mathematics", Khanna Publication.
3. H K Das, "Advanced Engineering Mathematics", S. Chand & Company.
4. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2008.
5. T. Veerarajan, "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Apply** knowledge of mathematics in engineering and technology.	3
2	**Identify, formulate** and **solve** engineering problems.	4
3	**Design** Mathematical models for engineering problems & solve them.	5
4	**Use** partial derivative to find total derivative of implicit functions and to find Jacobians.	4
5	Find error and approximate values of problems **related** to engineering field.	4

Course Title: Physics

Course Code: BSC-102

Theory:-3 Hrs./week + 1Hr

Practical:-3 Hrs. /week Total Credits (Theory + Practical):-5.5

Course Prerequisite:

This course is aimed at introducing the fundamentals of basic sciences to undergraduate students. The background expected includes a prior knowledge of physics and mathematics from H.SC. (science) and familiarity with various laws, principles and theories. The goals of the course are to understand the basic principles of science(physics) and their applications in different areas.

Course Objective:

The objective of this course is to provide learner with basic concepts and knowledge of sciences (various principles, theories, laws etc.) and to analyze it from experiments. The learner can apply the same in Chemical Engineering and Technology.

UNIT I:

Laws of electrostatics, electric current and the continuity equation, laws of magnetism, Ampere's law, Faraday's laws. Maxwell's equations. polarization, permeability and dielectric constant, polar and nonpolar dielectrics, internal fields in a solid, Clausius-Mossotti equation, Millikan's oil drop experiment.

Magnetic materials: Magnetization, permeability and susceptibility, diamagnetic, paramagnetic, ferromagnetic, anti-ferromagnetic &ferromagnetic materials, Hysteresis, applications. (10)

UNIT II:

Interference: Conditions for interference of light, Interference in thin films, Newton's Rings experiment.

Diffraction: Fresnel & Fraunhofer diffraction, diffraction grating, Characteristics of diffraction grating and its applications.

Polarization: Introduction, polarisation by reflection, double refraction, scattering of light, circular and elliptical polarisation, optical activity, polariods, applications of polaroids. (10)

UNIT III:

Introduction to quantum physics, blackbody radiation, Stefan's law. Explanation using the photon concept, photoelectric effect, Einstein's equation, photo-multiplier tubes, solar cell-working, merits and demerits. Production and detection of ultrasonic waves, properties and application of ultrasonic waves. (10)

UNIT IV:

Semiconductors: energy band diagram for conductor, semiconductor and insulator, Fermi level

& Fermi function. Position of Fermi level in semiconductors in intrinsic and extrinsic semiconductors. Effect of temperature on the Fermi level.

Superconductivity: principle of superconductivity, properties of superconductors, Type-I and Type-II superconductors, applications of superconductors. (10)

UNIT V:

X-Rays: Production & properties of X-Rays, characteristics and continuous X-rays, Moseley's law, engineering applications of X-rays.

LASER: Principle and working, spontaneous and stimulated emission, population inversion, types of LASER-solid state, semiconductor and gas, application of LASERS. (10)

Text/Reference Books:

1. Concepts of Modern Physics, S. L. Gupta and S. Gupta.
2. Concept of Modern Physics, AurtherBiser, EditionThree.
3. Engineering Physics, R. K. Gaur & S.L. Gupta.
4. Applied Science - II by S. J. Walzade& S. N.Narkhede
5. Physics for Scientist and Engineers-5th Edition, Paul Tipler, Gene Mose
6. Text book of Engineering Physics, M. N. Avadhanulu, P. G. Kshrisagar,S. Chand Publication
7. M. R. Srinivasan, "Physics for Engineers", New Age International Publishers.
8. "Optics", S. Chand Publication, N. Subrahmanyam, M.N.Avadhanulu.
9. "Engineering Physics", Sanjay Jain, Universities Press (India) Pvt Ltd.
10. "Semiconductor physics devices", Donald A. Neamen, MC Graw Hill Publication.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	To the concepts of Electromagnetism, basic laws related to magnetic and dielectric properties of material.	2
2	The concepts of Optics such as interference, diffraction and polarization.	2
3	Some of the basic laws of quantum mechanics, Photoelectric effect	2
4	Basic concepts of Semiconductors, superconductors.	2
5	The X-rays, LASERS, Principles, production, properties and **applications** of X-rays and LASERS.	3

Physics Lab

Practical:-3 Hrs. / week Credits: -1.5

Course Prerequisite:

In this laboratory, course emphasis is on the understanding of basic principles, characteristic – properties of different instruments used in a field of optics, Heat and thermodynamics, Modern Physics and electronics. The learner here can use this knowledge and apply in various branches of engineering as required.

Course Objective:

The objective of the laboratory is to impart the fundamental knowledge of physics to the students and develop their ability to apply the specific procedures to analyze the experimental results.In this lab, students will be familiar with the use of different equipment's, basic principles, properties etc. which they can apply in various disciplines of engineering during their studies and in future.

Practical's List:

1. Determination of Stefan's constant.
2. Newton's Rings for the determination of radius of planoconvex lens.
3. Determination of specific rotation of given solution using polarimeter.
4. Determination of wavelength of Laser light by using diffraction grating.
5. To study I-V Solar cell characteristics.
6. To study I-V Characteristics of Photo-cell.
7. Surface Tension by capillary rise method.
8. e/m by Magnetron method.
9. Determination of Planck's constant using photocell.
10. Determination of divergence of He-Ne Laser beam.
11. Determination of conductivity of the sample by four probe method.
12. Thermal conductivity by Lee's method.

Text/Reference Books:

1. N Avadhanulu, A. A. Dani, P M Pokley, "Experiments in Engineering Physics", S.Chand Publication.
2. S P Singh, "Advanced Practical Physics", Pragati Prakashan.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Use** the latest techniques, skills, and modern tools necessary for engineering practices.	3
2	**Design** a component, system or process to meet desired needs with in realistic constraints.	6
3	**Determine** the values of constants such as Stefan's constant, Planck's constant specific charge etc	3

Course Title: Chemistry-I

Course Code: BSC-103

Theory:-3 Hrs./week + 1Hr. **Tutorial Credit:4.0**

Total Credits (Theory + Practical):-5.5

Course Prerequisite:

The background expected includes a prior knowledge of chemistry, H.S.C. (Science) and familiarity with various laws, principles and theories.

Course Objectives:

This course provides basic knowledge of chemistry for undergraduate students of technology. It will develop their fundamentals to build own interface of applied chemistry concepts with industrial applicability in branch of chemical technology. This course will introduce to basic concepts of bonding, quantum chemistry, synthetic methodology, reagents in organic synthesis and influence of structure and its properties on bonding and chemical reactions.

UNIT-I: Quantum Theory

Introduction to quantum theory for chemical system: Postulates of quantum mechanics, Schrodinger equation, Application to hydrogen atom, Atomic orbitals (10)

UNIT-II: Chemical Bonding in Molecules

Coordination Chemistry, Magnetic properties and electronic spectra of complexes, bioinorganic-chemistry (haemoglobin, myoglobin, chlorophyll), organometallic chemistry.(10)

UNIT-III: Reactivity of organic molecules

Factors influencing acidity, basicity, and nucleophilicity of molecules, kinetics Vs thermodynamic control reaction. (10)

UNIT-IV: Selective name reactions

Aldol condensation, Perkin reactions, Michael addition, Mannich reaction, Reagans: $LiAlH_4$, $NaBH_4$, DCC, SeO2, crown ether. Rearrangement: Pinacol rearrangement, Beckman rearrangement, Favorskii rearrangement, Wolff rearrangement.(10)

UNIT-V: Strategies for synthesis of organic compounds

Reaction intermediates. Introduction to green chemistry, principles and concepts of green chemistry. Waste production, problem and prevention. Alternative reaction media, solvent-less reaction, Industrial uses of aqueous solvents. (10)

Text/Reference Books:

1) Molecular Quantum Mechanics, Fifth Edition, Peter W. Atkins and Ronald S. Friedman

2) Principles of Quantum Mechanics, Authors: Shankar, R.

3) Organic Chemistry, I L Finar, Vol-I and Vol-II

4) Organic Chemistry, Morrison and Boyd,

5) Organic Chemistry, S H Pine

6) Organic Reaction Mechanism, P S Kalsi

8) Organic Chemistry; Jonathan Clayden, Nick Greeves, Stuart Warren, OUP Oxford.

9) Organic Reaction Mechanisms; V. K. Ahluwalia, Rakesh Kumar Parashar; Edition 4; Publisher: Alpha Science International, 2011.

10)Concise Inorganic Chemistry, 5th Ed; J. D. Lee; John Wiley & Sons

11)Green Chemistry 3rd Edition; Mike Lancaster; Royal Society of Chemistry

Course outcome:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Appreciate** quantum theory of chemical system.	2
2	**Appreciate** co-ordination chemistry	2
3	**Write** simple organic mechanism	3
4	**Summaries** newer methods in organic synthesis	5
5	**Understand**environmental friendly chemistry	2

Chemistry –I Lab

Practical: 03Hrs./ Week **Credits: 1.5**

Course Objectives:

Course objective are practical applicability of theoretical concepts of basic organic chemistry and thermodynamics to its practical applications.

About 08-10 experiments to illustrate the concept learn in chemistry -I

Suitable number of experiments from following categories.

1) Identification of organic compounds through group detection, physical constant (MP/BP)

2) Synthesis of Organic compound involving reactions such as oxidation, esterification, nitration, sulphonation etc.

3) Measurements of kinetics of simple reactions.

Text/Reference Books:

1) Qualitative organic and inorganic analysis by Kulkarni and Pathak.
2) T.Y. Practical chemistry by A.M.Nemade, V.S.Zope.

Course outcome:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Identify** the simple organic compound	1
2	**Identify** reaction rate parameter,	1
3	**Perform** and **optimize** the reaction conditions.	3

Course Title: Communication Skills

Course Code: HMC-101

Theory: 02Hrs. /Week **Credits:2.0**

Course Objectives:

To achieve the following objectives through this course:

a) To make the student industry ready in terms of his/her ability to communicate effectively

b) To augment the ability of the student to create, compose and render presentations with or without the help of media

c) To understand the importance of public speech and the role language plays in that.

d) To enhance the ability of written communication by giving a primer on English

UNIT I: **Communication Skills:** Introduction to major grammatical models. Phonological and syntactical structure of present-day English. Language of science and technology. Aspects of style. Vocabulary building, spelling patterns, some common errors, Reading and Comprehension Organizing principles of paragraphs in documents (05)

UNIT II: Communication Effectiveness: Importance of proper punctuationFormal and informal communication. The art of listening.ListeningComprehension,Strategies for effective communication, Social perception communication, written communication. Writing introduction and conclusion.Managerial report writing. Graphical representation of technical data, Technical presentations design and delivery. Resume Writing, Business etiquettes, social grace.
(05)

UNIT III: Personality Development: Concept of Soft Skills, Problem solving, decision making, Positive Attitude and mindset, Communication at Work place,Analytical Skills, Basic Writing Skills,Desire to learn and to be trained, coping with stress, Précis Writing Essay Writing, Multitask ability, Time Management, Model of success and failure in adjustment.(05)

UNIT IV: Interpersonal skills and rapport: Work Ethics, Personal Integrity &commitment, Flexibility, Team work and spirit, Group process, Group task performance, Adaptation development processes, Cultural influences on personality and social behaviour. Managing Ability, Aggression and its management. (05)

UNIT V: Problem solving co-operation and competition, Motivational Skills:

Personality and social phenomenon. Negotiation Skills, Networking with industries and institutions. Approaches to the study of personality. Models of healthy & mature personality; Describing oneself and SWOT analysis, Emotional Intelligence. (05)

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the importance of communicating effectively	2
2	**Communicate** effectively by removing barriers	3
3	**Address** an audience effectively & deliver speeches without inhibition	3
4	**Create** and **deliver** effective e-presentations	3
5	**Understand** the meaning and utility of Active Listening in communication	2
6	**Use** the vocabulary more effectively	3
7	**Expand** and **enrich** grammatical structure and vocabulary in English	3
8	**Comprehend** thoughts through body language and **use** it as a tool to understand non-verbal.	3

Communication Skills

Practical: 02Hrs. /Week **Credits: 1.0**

Practical's List:

1) Pronunciation & Spelling
2) Stress and Intonation
3) Errors in Spoken English
4) Business Letter (Layout)
5) Job application with Resume preparation
6) Newspaper Reading

Text/Reference Books:

1. English Pronouncing Dictionary, Cambridge University Press, India, 2012.
2. A Textbook of English Phonetics for Indian Students by T. Balasubramanian, Macmillan Publisher,

Course Title: Engineering Graphics

Course Code: ESC-102

Theory: 01 Hrs./Week **Credits: 1.0**

Course Prerequisite:

Engineering Graphics is the language of engineers. The concepts of Engineering Graphics are used to develop, express the ideas, and convey the instructions which are used to carry out jobs in the field Engineering. The course illustrates the techniques of graphics in actual practice. This preliminary course aims at building a foundation for the further course in drawing and other allied subjects. This subject is useful in developing drafting and sketching skills of students.

Course Objective:

The student after studying this subject will be able to:-

1. Draw different engineering curves and know their applications.
2. Draw orthographic projections of different objects.
3. Visualize three dimensional objects and draw Isometric Projections.
4. Understand the basic concepts of projection of different entities.
5. Visualize and draw views of objects in various positions.
6. Develop lateral surfaces of different solids

Course Contents:

Unit - I: Introduction to Engineering Graphics

Principles of Engineering Graphics and their significance, usage of Drawing Instruments and Supporting Material, Letters and Numbers as per BIS: SP46-2003, Scale (Plane, diagonal &Vernier scale) .

Curves and Conic Section draw ellipse by directrix and arc of circle method. draw parabola by directrix and rectangle method. Draw hyperbola by rectangle and directrix method. Cycloid, Epicycloid, Hypocycloid and Involute. (04)

Unit – II: Orthographic Projections

Orthographic Projection: Types of lines, Methods of dimensioning, first angle method of projection and third angle method of projection. Principle of Orthographic Projections, Projections of Points, Projection of Line, Lines inclined to both the Planes.

Projection of different simple shapes e.g. Circle, Triangle, Rectangle, Pentagon and Hexagon on principle plane (Inclined to one plane and to both planes). Conversion of pictorial view into sectional orthographic views. (04)

Unit – III: Projection of Solids

Introduction to solids, prism, cone, cylinder, pyramid, cube, tetrahedron. Projection of above solids with axis inclined to one plane and both planes. (04)

Unit – IV: Section of Solids

Introduction, section planes, true shapes of section, section plane parallel to VP, section plane parallel to HP, section plane perpendicular to HP and section plane inclined to VP, section plane inclined to HP. Section of prism, section of pyramid, section of cone, section of cylinder. (04)

Unit – V: Isometric Projection

Introduction to pictorial views, Isometric axes, lines and plane, true scale and Isometric scale. Isometric projection and Isometric View Conversion of given orthographic view into isometric projection. (04)

Engineering Graphics Lab

Practical: 04 Hrs/Week **Credits: 2.0**

Course Contents:

1. One drawing sheet on Lettering & Numbering
2. One drawing sheet on Engineering curves: Three different curves are to be draw using any one method
3. One drawing sheet on Projection of lines and Planes: Two problems on projection of lines and two problems on projection of planes
4. One drawing sheet on Projection of Solids: Two problems on two different solids
5. One drawing sheet on Section of Solids: Two problems on two different solids
6. One drawing sheet on Isometric Projections: Isometric views of two objects

Text/Reference Books:

1. Engineering Drawing: N.D. Bhatt, V. M. Panchal, by Charotar Publication
2. Engineering Drawing: M. L. Dobhade (Vol I + II), by Vision Publications
3. Engineering Drawing: P. S. Gill, by S. K. Kataria Publications
4. Engineering Drawing: Mali and Chaudhari
5. Engineering Drawing: H. G. Phakatkar, By NiraliPrakashan
6. Engineering Drawing: Venugopal and Prabhu Raja V

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Use** various drawing instruments to layout and draw a sheet.	3
2	**Explain** several types of lines used, Lettering, Numbering and Dimensioning and Scales.	2
3	**Draw** and **explain** Planes of projection, quadrants and first angle & third angle method of projection. To draw front view, Top View and side View of Simple objects.	3
4	**Illustrate** Principles of Isometric projection and Isometric view.	4
5	**Explain** energy management strategy and energy audit.	2
6	**Illustrate** with principle various conventional energy producing devices and energy absorbing devices.	4
7	**Illustrate** with principle various power transmission elements, drives,	4

	direction and flow control valves.	

Course Title: Induction Programme

Course Code: NC-101

Course Type: Audit **Total Hrs: 3 Weeks at the start of Semester-I**

Course Credit: NC

Course Objectives:

1. It aims at helping new students to adjust and feel comfortable in new environment
2. It will facilitate the students for self-exploration and helps to rectify critical lacunas if any.
3. It will develop ethical thinking in student to understand the importance of value-based education.

There will be a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. The purpose of the *Student Induction Programme*is to help new students adjust and feel comfortable in the new environment, inculcate in them the ethos and culture of the institution, help them build bonds with other students and faculty members, and expose them to a sense of larger purpose and self-exploration.

Student Induction Program engages with the new students as soon as they come into the institution. At the start of the induction, the incumbents learn about the institutional policies, processes, practices, culture and values, and their mentor groups are formed. The time during the Induction Programme is also used to rectify some critical lacunas, for those students who have deficiency in it. Different activities, including those which are daily are to be planned. Here is a list of activities:

- Physical Activity
- Creative Arts and Culture
- Mentoring & Universal Human Values
- Familiarization with College, Dept./Branch
- Literary Activity
- Proficiency Modules
- Lectures & Workshops by Eminent People
- Visits in Local Area
- Extra-Curricular Activities in College
- Feedback and Report on the Program

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	Familiar with the institutional and departmental policies, processes, and practices	1
2	Get sensitized to the engineering needs of the society.	1
3	Understand the importance of healthy lifestyle, yoga, meditation in their professional development	2
4	Understand the broader perspective of universal human values in technical education	2

References:

1. Student Induction Program: A Detailed Guide by AICTE dated 30 July 2018 https://www.aicte-india.org/content/student-induction-program-detailed-guide
2. A Guide to Student Induction Programme by UGC dated 15 August 2018 https://www.ugc.ac.in/pdfnews/0559509_A-Guide-to-Student-Induction-Programme.pdf

Semester-II

Course Title: Mathematics- II

Course Code: BSL-104

Theory: 03Hrs. + 01 Tutorial/ Week **Credits: 4.0**

Course Prerequisite:

Mathematics H.S.C. and BSL-101 (Mathematics-I) course of F. Y. B. Tech. (Semester-I).

Course Objectives:

To make aware students about the importance and symbiosis between Mathematics and Engineering. To develop the ability of mathematical modelling of systems using differential equations and ability to solve the differential equations.

Unit –I: Linear Differential Equations of n^{th} Order with Constant Coefficient

Solution of LDE of order n with constant coefficients, Method of variation of parameters (only second order), Cauchy's linear equation and Legendre's linear equation. (10)

Unit –II: Applications of Linear Differential Equations and Partial Differential equations

Applications of linear differential equations to Chemical Engineering, Applications of Partial Differential equations to one dimensional heat flow equation and two-dimensional heat flow equation. (10)

Unit –III: Laplace Transform

Definition and existence of Laplace transforms, Theorems and Properties of Laplace Transform (without proof), Laplace Transform of some special functions, Inverse Laplace Transform, Convolution Theorem, Solution of linear differential equations using Laplace Transform. (10)

Unit –IV: Multiple Integrals and Their Applications

Double integrals and their evaluation; Change of order for integration; Double integrals in polar coordinates; Triple integrals; Application of multiple integrals to find area, volume, surface area. (10)

Unit –V: Complex Variable

Analytic function, Harmonic function, Cauchy Riemann equations, Cauchy integral formula, Cauchy

integral theorem, Residue theorem and Bilinear transformation. (10)

Text/Reference Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Eastern Ltd, 10th Edition.
2. B S Grewal, "Higher Engineering Mathematics", Khanna Publication.
3. H K Das, "Advanced Engineering Mathematics", S. Chand & Company.
4. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2008.
5. T. Veerarajan, "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.
6. S. C. Gupta, "Fundamental of Statistics", Publisher: Himalaya Publishing House Pvt. Ltd.; Seventh Edition (2016).

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Apply** knowledge of mathematics in engineering and technology.	3
2	**Draw** the rough sketch of Cartesian and polar curves.	3
3	**Use** shift theorems to compute the Laplace transform, inverse Laplace transform and the	5
4	**Use** the knowledge of multiple integrals in finding the area and volume of any region bounded by the given curves.	5
5	**Evaluate** multiple integrals using spherical polar and cylindrical polar coordinates.	5
6	**Understand** analytic function of a complex variable. Able to **apply** Cauchy Integral theorem and Cauchy residue theorem to solve contour integrations.	3

Course Title: Thermodynamic-I

Course Code: BSL-105

Theory: 03Hrs. + 01 Tutorial/ Week **Credits: 4.0**

Course Prerequisite:

The background expected includes a prior knowledge of physical chemistry, H.S.C. (Science) and familiarity with various basic laws, principles and theories.

Objectives:

Course objective are practical applicability of theoretical concepts of basic organic chemistry and thermodynamics to its practical applications.

UNIT-I: Introduction to Thermodynamics

Scope of thermodynamics, systems and process, homogeneous and heterogeneous system, closed and open systems, state functions, equilibrium, reversible process, irreversible process. (10)

UNIT-II : First law of thermodynamics and gas laws

work, energy, first law of thermodynamics, internal energy, Gas law: Boyl's law, Charls law, Avogadro's law, ideal gas equation, van der waals constant.

(10)

UNIT-III: Second law of thermodynamics

Heat engine, Carnot theorem. Heat effect: latent heat, sensible heat, standard heat of formation, reaction and combustion. Entropy, Enthalpy, Second law of thermodynamics. (10)

UNIT-IV: Some applications of the laws of Thermodynamics

Flow processes, continuity equation, energy balance, flow in pipes, flow through nozzles, ejectors, throttling process, compressors. (10)

UNIT-V: Refrigeration

Coefficient of performance, refrigerator capacity, Vapour- compression cycle, Absorption refrigeration, heat pump, Liquefaction processes. (10)

Text/Reference Books:

1) J M Smith, H C Van Ness and M M Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw- Hill International Edition, 2005.

2) M J Moran, H N Shapiro, D DBorttner and M B Bailey, Principal of Engineering Thermodynamics, 8th Edition, Willey.

3) K.V. Narayanan, A textbook of chemical engineering thermodynamics, PHI, Delhi,2001.

Course outcome: Student will be able to

a) Appreciate the thermodynamic aspects

b) Apply mass and energy balances

c) Study basic laws of gases

d) Solve the problems involving the liquefaction, refrigeration and different power cycles.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Appreciate** the thermodynamic aspects	2
2	**Apply** mass and energy balances	3
3	**Study** basic laws of gases	1
4	**Solve** the problems involving the liquefaction, refrigeration and different power cycles.	5

Course Title: Electrical & Electronics Engineering

Course Code: ESL-102

Theory: 03Hrs. + 01 Tutorial/ Week **Credits: 4.0**

Course Prerequisite: The course provides basic knowledge of electrical engineering. Course explores the knowledge of electrical, magnetic circuit and AC circuit. Course also provides the basic working operation of different electrical machine along with their characteristics and applications. It also provides ideas of electrical installation and different switches. Higher standards of safety and precautions are important in any industry Chemical industries therefore electrical safety and safety measures also incorporated in the course. Energy calculation and optical use of electrical energy are important in view of entrepreneur, electric tariff also included in the syllabus.

Course Objectives:

1. Students will able to understand the basic concept of electric power, energy in the field of chemical engineering and technology.
2. Students will able to understand the characteristic of motor for suitability of different applications in chemical engineering and technology.
3. Students will able to control and use electrical appliances in chemical engineering and technology.
4. Students will able to calculate power and energy for efficient, economical process of plants.
5. Students will able to apply good electrical safety precaution even in temporary works.

Unit-I: DC Circuits

Electrical circuit elements (R, L and C), voltage and current sources, open and short circuit in series and parallel circuit, effect of temperature on resistance. Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Loop analysis, Superposition and Thevenin Theorems. Magnetic circuit: Concept of magnetic circuit, MMf, Flux and reluctance. Magnet circuit, composite magnetic circuit, Comparison of magnetic and electric circuit, B-H curve, hysteresis and eddy current loss. (10)

Unit-II: AC Circuits

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections. Power in three phase circuit, Measurement of power in three phase circuit. (10)

Unit-III: Transformers

Magnetic materials, ideal and practical single-phase transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections. (10)

Unit-IV: Electrical Machines

DC Motor: Construction of DC motor, working operation, back emf, need of starter, classification of DC motors, torque, speed, characteristic of DC motor, speed control and applications.

AC Motor; Construction, working operation of three phase induction motor, Torque slip characteristic of induction motor, loss components and efficiency, Slip ring induction motor and applications. Classification and application of single phase motors (10)

Unit-V: Electrical Installations

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, small and medium industrial electric tariff, power factor improvement and battery backup. Electrical safety precaution and measures in chemical industry.

(10)

Text / Reference Books:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
6. B L Theraja, " Electrical Technology Vol-I and II", S Chand Publication
7. V N Mittal, "Basic Electrical Engineerin"

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Apply** basic knowledge of science and mathematics for understanding basic electrical engineering problems.	3
2	**Understand** the working principles of different motors and their applications in chemical engineering and technology.	2
3	**Understand** power consumption, energy cost in view of efficient use of electrical energy.	2
4	**Select** correct rating of fuse and MCB for protection scheme and	4

	safety.	
5	**Use**of the modern electrical machines tools in the field of the chemical engineering and technology with the higher safety standard.	3

Course Title: Computer Lab (Programming for problem solving)

Course Code: ESC-103

Theory: 03Hrs./ Week **Credits: 3.0**

Course Prerequisite: This course provides students with a comprehensive study of the C programming language. Introduction to program design and problem solving using the C programming language. Programming topics include control structures, functions, arrays, pointers, and file I/O.

Course Objectives: To impart knowledge so that the student will:

1. Learn the fundamentals, structure and syntax of C Language.
2. Write simple programs in C Language.

UNIT-I:

What is C ?, The C Character set, Constant, Variables & Keywords, Types of C Constants, Rules for constructing Integer Constants, Rules for constructing Real Constants, Rules for constructing Character Constants, Types of C Variables, Rules for constructing Variable Names, C keywords, Comments in a C Program, Types of instructions, Type Declaration instruction, Arithmetic instruction, Integer and Float Conversion, Type Conversion in Assignments, Hierarchy of Operations, Associativity of Operations, Control instructions, Data Types Revisited: Integers, long & short, signed & unsigned, Chars, signed & unsigned, Float & Doubles, Console Input/Output: Types of I/O, Console I/O Function, Formatted Console I/O Functions, Unformatted Console I/O Functions, Decision Control Instruction: The if statement, Multiple Statements within if, The if- else statement, Nested if-else, Use of Logical Operators, The else if Clause, The !Operator.(08)

UNIT-II:

Loop Control Instruction: Loops, the while Loop, Tips & Traps, More Operators, The for Loop, Nesting of Loops, Multiple Initializations in the for Loop, The break Statement, The continue Statement, The do-while Loop, The Odd Loop, Case Control Instruction: Decisions using switch, The Tips & Traps, switch versus if-else Ladder, The goto Keyword. (08)

UNIT-III:

Functions: What is a Function? Why use Functions? Passing Values between Functions, Scope Rule of Functions, Order of Passing Arguments, Using Library Functions, Pointers: Call by Value and Call by Reference, An Introduction to Pointers, Pointer Notation, Back to Function

Calls, Recursion Function. (08)

UNIT-IV:

Arrays: What are Arrays? A Simple Program using Array, More on Arrays, Array Initialization, Array Elements in Memory, Bounds Checking, Passing Array Elements to a Function, Pointers and Arrays, Passing an Entire Array to a Function, The Real Thing, Multidimensional Array: Two Dimensional Arrays, initializing a Two-Dimensional Array, Memory Map of a Two-Dimensional Array, Pointers and Two Dimensional Arrays, Pointer to an Array, Passing 2-D Array to a Function, Array of Pointers. (08)

UNIT-V:

Strings: What are Strings? More about Strings, Pointers and Strings, Standard Library String Functions, Handling Multiple Strings: Two-Dimensional Array of Characters, Array of Pointers to strings, Limitations of Array of Pointers to Strings, Structures: Why use Structures? Declaring a Structure, Accessing Structure Elements, How Structure Elements are Stored? Array of Structure. (08)

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the fundamentals of C programming.	2
2	**Choose** the loops & decision-making statements to **solve** problem.	6
3	**Use** functions to **solve** the given problem.	6
4	**Implement** different Operations on arrays.	3
5	**Understand** strings and structures.	2
6	**Understand** the usage of pointers.	2

Computer Lab

Theory: 04Hrs./ Week **Credits: 2.0**

Course description: This course provides students with a comprehensive study of the C programming language. Introduction to program design and problem solving using the C programming language. Programming topics include control structures, functions, arrays, pointers, and file I/O.

Course Objectives: To impart knowledge so that the student will:

1. Learn the fundamentals, structure and syntax of C Language.
2. Write simple programs in C Language.

Course Content:

1. Write a C program to find area of circle, triangle, rectangle, square using switch statement.
2. Write a C program to find the sum of a series (looping).
3. Write a C program to accept a string and reverse it without using library functions. Display the original and reversed string. (String handling).
4. Write a C program that uses functions to perform the following string operations using function and pointers:
    i) To insert a sub-string in to given main string from a given position.
    ii) To delete n Characters from a given position in each string.
5. Write a C program to read 'N' elements into an array and compute the sum of all the elements stored in an array using pointer. (Arrays and pointers).
6. Write a C program to read a matrix of order (M *N) and (P * Q) and compute the addition and multiplication of two matrices. (Passing matrix to functions).
7. Write a C program to read 'N' students information and display the information with appropriate headings, where each student information consists of roll number, Name, total marks scored etc. (Structure handling).
8. Write a C program to find Factorial using Recursion.
9. Write a C program for Root Finding using Numerical Methods.
10. Write a C program to solve Linear Equations.

Text /Reference Books:

1. "Programming in ANSIC C" by E Balagurusamy, Tata McGraw Hill, 4/E, 2007
2. "Mastering C" by K. R. Venugopal and S. R. Prasad, Tata McGraw Hill, 2011
3. "The C Programming Language" by Brian W. Kernighan and Dennis M. Ritchie, PHI
4. "C How to Program" by Paul Deitel and Harvey Deitel, 8th Edition, Pearson
5. "Let Us C" by YashavantKanetkar, 14th Edition, BPB Publication.
6. "Test Your C Skills" By YashavantKanetkar, 5th Edition, BPB Publication.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the fundamentals of C programming.	2
2	**Choose** the loops & decision-making statements to **solve** problem.	6
3	**Use** functions to **solve** the given problem.	6
4	**Implement** different Operations on arrays.	3
5	**Understand** strings and structures.	2
6	**Understand** the usage of pointers.	2

Course Title: Material Science &Technology Course Code: ESL-104

Theory: 03Hrs./ WeekCredits: 3.0

Course Prerequisite:

The goals of the course are to understand the basic principles of Material science and their applications in different areas. The background expected includes a prior knowledge of physics and Chemistry from H.S.C. (Science) and familiarity with various laws, principles and theories.

Course Objectives:

The objective of this course will provide the students basic introduction to different concepts of Materials, different classes of materials relevant to Chemical Engineering. The intent of the course will be to relate the underlying molecular structure of the materials to their physical and chemical properties, and their processing and performance characteristics.

UNIT – I

Classification of solids (Amorphous, crystalline, polycrystalline), Space lattice, Bravais Lattices. Miller Indices, inter planar distances, Co-ordination number, Packing fractions. Imperfections in solids: point defects (stoichiometric defects and no stoichiometric defects), line imerfections, surface imperfections, volume imperfection. (08)

UNIT – II

Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, vanderwaals bond, hydrogen bond. Mechanical properties of solids such as plastic deformation, Mechanism of plastic deformation-slip, twinning, modulus of elasticity, tensile strength, ductility, toughness, elongation, plastic deformation, Schmid's law. Creep, requirement for creep resistance material, fracture, fatigue. (08)

UNIT – III

Classification of engineering materials (Metals, Polymers, Ceramics, Composites, Nanomaterials and Biomaterials). Polymers: classification of polymers, mechanism of polymerization, crystallization of polymers. Ceramics and glasses- properties of ceramics, Types of ceramics, electrical properties of ceramics, glasses, cermets. Nanomaterials- Introduction to nonmaterials, properties. Fabrication process-top down and bottom up

approach.Composite materials-dispersion reinforced composites, laminated composites, fiber reinforced composites, loading under isostrain and isostress condition. Biomaterials. (08)

UNIT – IV

Corrosion: Electrochemical principles, mechanisms, Formation and Growth of film, Growth Laws, polarization. Types of corrosion, prevention and control. Protective coatings, Application of inhibitors. Role of materials selection in design, structure-property–processing-performance relationships.

(08)

UNIT – V

Material characterization techniques, X-Ray Diffraction, Braggs X-ray spectrometer, Debye Scherrer Camera. Principles of Raman Spectroscopy. Particle size analyzers. (08)

Text/Reference Books:

1. Material Science and Engineering Metallurgy: V. D. Kodgire.
2. Material Science: G.B.S. Narang.
3. Material Science: O P Khanna.
4. Engineering Metallurgy and Material Science: S.P. Nayak.
5. Material Science: Raghavan.
6. Material Science: Hazra Chaudhari.
7. Principles of Material Science and Engineering: William F. Smith
8. Material Science-Tata MC-Graw Hill Publication, V. Rajendran, R. A. Maricani.
9. Material Science and Engineering an Introduction, William D. Callister, David G. Rethwisch. WILEY Publications.
10. Instrumental Methods of Chemical Analysis, Gurdeep R. Chatwal, Sham K Anand.
11. Nanotechnology: Principles and Practices: S. K. Kulkarni.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Acquaint** students with the basic concepts and properties of Materials and their use in Engineering applications.	2
2	**Develop** futuristic insight into Materials and introduction to some	6

	characterization technique	

Syllabus of Second Year
B. Tech. (Chemical Engineering)

(Revised Syllabus w. e. f. 2019-20)

Faculty of Science and Technology

University Institute of Chemical Technology

Kavayitri Bahinabai Chaudhari

North Maharashtra University,

Jalgaon

(Academic Year 2019 – 20)

Semester-III (Second Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
BSC-206	Chemistry-II	03	01	04	03	1.5	5.5
ESL-205	Engineering and Solid Mechanics	03	01	04	-	-	4.0
CHL-201	Thermodynamics-II	03	01	04	-	-	4.0
ESC-206	Engineering Workshop	01	-	01	04	02	3.0
CHC-202	Transport Phenomena	03	01	04	-	-	4.0
NC-202	Constitution of India	-	-	-		NC	NC
Total Credit							**20.5**

Course Title: Chemistry-II

Course Code: BSC-206

Theory: 04 Hours/week (Teaching Hours: 03, Tutorial: 01) **Total Credits: 04**

Course Prerequisite: Chemistry-I

Course Objectives:

1. To develop the arts and culture of organic chemical reactions and its significance in chemical and technology process industry.
2. To study how chemical reactions takes place differently in different environments i.e., reaction mechanism.
3. To study and apply the basic reactions mechanism to design synthesis of some classes of molecules.
4. To study industrially important chemical reactions, substrate and some reagents.
5. To study interconversion of functional group and their applications.
6. To study methods of determination of structure of molecules.

Course Contents:

UNIT- I

Aromatic molecules: Huckels rule of aromatic molecules, different classes of aromatic molecules, resonance.

Aromatic Electrophilic Substitution bimolecular reactions (ArSE2 reactions): Mechanism of ArSE2 reaction, Orientation of ArSE2 reaction in monosubstituted benzene, Mechanism and synthetic application of Nitration, Friedel-Craft's alkylation and acylation reactions, Gatterman-Koch reaction, Vilsmeier-Haack's reaction. (10)

UNIT-II

Aromatic amines: Methods of Preparation – benzyne mechanism, reduction of nitro aromatics, properties-basicity and application in synthesis.

Diazonium Salts: Preparation-diazotization reaction, chemical properties and reactions such as coupling, synthesis of azo dyes, replacements-Sandmeyer's reaction and deamination. Ullman's reaction and Benzidine rearrangement. (10)

UNIT-III

Reagents and Green solvents in organic synthesis:

Complex Metal hydride-DIBAL-H, Lithium dimethyl cuprate, applications in synthesis. Introduction to organoboron-diborane, organosilicon-silane. H2O2 and O3(Ozone) application in organic synthesis. Introduction to Green reactions, Green and hazardous solvents. (10)

UNIT-IV

Sulphonic acids: Methods of preparation, application of sulphonic acids in synthesis.

Heterocyclic compounds: Introduction, Methods of synthesis and ArSE2 reactions such as nitration,sulphonation, halogenations, acylation and mercuration of Furan, Pyrrole and Pyridine. (10)

UNIT-V

Spectroscopy: Basic principles and applications of IR, UV-VIS and ^{1}H NMR spectroscopy to structure determination of small molecules. (10)

Text/ Reference Books:

1. S. H. Pine, Organic Chemistry, Tata McGraw-Hill Education India, 5th Revised edition-1987
2. M. B. Smith, Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanism and Structure, Wiley-Interscience, 6th Edition2007.
3. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, Pearson, 7th Edition 2011.
4. Jonathan Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2000.
5. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, Cambridge University Press, 4th Edition 2012.
6. P. S. Kalsi, Spectroscopy of Organic Compounds, New Age International Pvt Ltd Publishers, 6th Edition, 2006.
7. Elementary Organic Spectroscopy, Y. R. Sharma, S. Chand & Co. 4th Edition 2007.

Course Outcomes:

Upon successful completion of the course students will have

CO No.	Course Outcome	Cognitive level
1	Clear basic **concepts** of different classes of organic molecules, their	1

	important reactions and functional group inter conversions.	
2	They would know how organic reactions are takes place, how to **design** the desired product and factors to take care of it.	6
3	They will understand how to **apply** different concepts of reactions to workup/separation of product, to improve yields and to study structure of molecules.	3
4	This course provides the knowledge of organic **concept** to undergraduate engineering students and is designed to strengthen the fundamentals so that they can build their own interface of applied organic chemistry concept with their industrial applications in the branch of chemical engineering andTechnology.	1

Chemistry-II Lab

Course Code: BSC-206 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Prerequisite: Chemistry-I practical

Course Objectives:

1. To develop the arts and culture of organic chemical reactions and its significance in chemical and technology process industry.
2. To study how chemical reactions are takes place differently in different environments i.e., reaction mechanism.
3. To inculcate the laboratory skills.

Course content:

1. Qualitative analysis of organic binary mixture through type determination, separation. Elemental analysis, functional group determination and physical constant of any one component (at least Two mixtures)
2. Single step preparation involving greener approach, purification and characterization (m.p.) of product (at least Three)
   - i) Preparation of dibenzalpropanone using NaOH or LiOH as base
   - ii) Preparation of p-nitro aniline from p-nitroacetanilide
   - iii) Bromination of acetanilide by CAN, KBr in water
   - iv) Preparation of Osazone from Glucose
   - v) Preparation of Sudan-I from aniline
   - vi) Preparation of p-nitrobenzoic acid from p-nitrotoluene
   - vii) Oxidation of alcohol to ketone by sodium hypochlorite (NaOCl)
3. Determinations/Estimations (Any Two)
   - i) Determination of total hardness of water
   - ii) Determination of Molecular Weight of a monobasic/ dibasic acid by volumetric method.
   - iii) Estimation of amide by hydrolysis
   - iv) Study of kinetics of hydrolysis of methyl acetate
4. Laboratory Techniques (any Three)
   - i) Thin Layer Chromatography (TLC)
   - ii) Hydrogenation of organic compound-a demonstration
   - iii) Interpretation of IR and UV-VIS Spectra

iv) Interpretation of 1H NMR spectra

Text/ Reference Books

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, Pearson, 5th Edition 2005.
2. R. K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Limited, 5th Revised Edition 2008.

Course Outcomes:

Upon successful completion of the course students will have

CO No.	Course Outcome	Cognitive level
1	Clear basic **concepts** of different classes of organic molecules, their important reactions with developed laboratory skill and awareness.	1
2	Basic concepts in preservation of environment by **adaptation** of Green Chemistry concepts.	6

Course Title: Engineering and Solid Mechanics

Course Code: ESL – 205

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Physics, Mathematics and Engineering Graphics

Course Objective:

- Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force systems, axioms, dynamics of rigid bodies.
- Second part of the course would be an introduction to Solid Mechanics, and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.

Course Contents:

Unit - I

Coplanar forces: Introduction, basic concepts, composition & resolution of forces. Resultant forces. Moment of forces, couples, equivalent force systems, free body diagrams, distributed forces. Equilibrium of coplanar force system, conditions of equilibrium. Types of supports. Support reactions for determination of beams. Problems on above topics.

Analysis of structure: Plane trusses, method of joints, cables subjected to part loads. (10)

Unit – II

Centroid &Centre of gravity of composite plane figures. Principal Moment of Inertia, Moment of Inertia of various geometry.

Friction: Laws of friction, Application of friction on horizontal & inclined planes, belt friction.

Introduction to point Kinematics: Curvilinear Motion: Moving point in various coordinate systems (Cartesian, cylindrical, path), Equation of motion.

Kinetics & Kinematics of Rigid body: Translation & Rotation motion, Linear and Angular velocity, momentum. (10)

Unit – III

Concept of stress & strain, classification, Hooke's law, Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Bulk modulus, relation between elastic constants, Problems on stresses & strains for prismatic, linear varying & composites sections.

Introduction to thermal stresses& strains. Problems on simple & composite sections. (10)

Unit – IV

Concept & definition of shear force & bending moment in determinate beams due to concentrated loads, UDL, UVL, Shear force & Bending moment diagrams for cantilever & simply supported beams (with or without overhang). Theory of bending. Concept of shear stress distribution. (10)

Unit – V

Thin Cylinder: Hoop stress, longitudinal stress, riveted cylindrical vessels, wire bound thin pipes. Thin spherical shells, cylinder with hemispherical ends.

Torsion of a circular shaft: Theory of pure torsion, Assumptions. Simple problems on torsion & power transmission. Short & long columns & struts. Standard cases with axial load. (10)

Text/Reference Books

1. I. B. Prasad, "Applied Mechanics & Strength of Materials", Khanna Publishers.
2. Timoshenko, "Mechanics of Materials", CBS Publisher
3. Ramamruthan S., "Strength of Material", Dhanpat rai Publications
4. Bear & Johnson, "Mechanics of Materials", 7th edition, McGraw-Hill Education, 2015
5. R. K. Rajput, "Strength of Materials", S Chand Publications
6. R S Khurmi, "Strength of Materials", S Chand Publications

Course Outcomes:

1. Able to solve basic concept in structural members like column, beams, trusses, and concept in laws of frictions and various types of stresses and strains.
2. Able to solve shear forces and bending moment and plot diagrams.
3. Able to analyse various parameters on torsion in transmission system.

Course Outcomes:

Upon successful completion of the course students will have

CO No.	Course Outcome	Cognitive level
1	**Solve** basic concept in structural members like column, beams, trusses, and concept in laws of frictions and various types of stresses and strains.	3
2	**Solve** shear forces and bending moment and plot diagrams.	3

3	**Analyze** various parameters on torsion in transmission system.	4

Course Title: Thermodynamics II

Course Code: CHL – 201

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Thermodynamics I

Course Objective: To introduce the concepts of fugacity, activity and their coefficients, Phase equilibria and Chemical reaction equilibria.

Course Contents:

Unit - I

Review of basic laws of thermodynamics, intensive and extensive properties, state and path function, calculation for work, enthalpy and entropy changes. Efficiency calculation to heat engine, heat pumps. Refrigeration cycle & Carnot cycle, Throttling Process. (10)

Unit – II

Properties of pure substances: T-V, P-V, P-T diagram. Ideal gas law, compressibility factor, Van der waals equation, Viral equation, Redlich Kwong equation, Redlich Kwong Soave equation of state. P- V-T relation for isothermal, isobaric, isochoric, adiabatic & polytropic processes. (10)

Unit – III

The Maxwell relations, method of Jacobians, Gibbs &Helmotz relations, the Clapeyron equation. The general relations for du, dh, C_v, &C_p ; Mayer relation. Isothermal compressibility, volume expansivity, coefficient of linear expansion, adiabatic compressibility & adiabatic bulk modulus. The Joule Thomson Coefficient. (10)

Unit – IV

Phase Equilibria: Chemical potential, Kay's rule, Phase rule for reacting system, Duhem's theorem, boiling point and equilibrium diagram, fugacity and activity coefficient, activity coefficient equations (Wohl's three-suffix equations; Margules equation; Van Laar equation; Wilson equation; Non-random two-liquid (NRTL) euation; Universal quasi-chemical (UNIQUAC) equation; Universal functional activity coefficient (UNIFAC)), Azeotropes, consistency tests for VLE data, modified Roult's law, liquid-liquid equilibria. (10)

Unit – V

Chemical Reaction Equilibria: Chemical equilibrium criteria, Equilibrium constant, chemical equilibria for simultaneous reactions, Feasibility of a reaction, Effect of temperature and pressure on equilibrium constant, Heterogeneous reaction equilibria. (10)

Text/ Reference Books

1) J.M.Smith, H.C.Van Ness and M.M.Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw-Hill International Edition, 2005.
2) K.V.Narayanan, "A textbook of Chemical Engineering Thermodynamics" PHI, New Delhi, 2010.
3) Y.V.C.Rao, "Chemical Engineering Thermodynamics" , University Press, Hyderabad,1997.
4) S.Sandler, " Chemical, Biochemical and Engineering Thermodynamics" , 4th edition, Wiley, India,2014.

Course Outcomes:

On completion of the course,

1.Students would be familiar with Basics of thermodynamics

2.Students would be familiar with various thermodynamics relations

3.Students will be able to solve problems of phase equilibria

4. Students will be able to solve problems of chemical equilibria

Course Outcomes:

Upon successful completion of the course students will have

CO No.	Course Outcome	Cognitive level
1	familiar with Basics of thermodynamics.	1
2	familiar with various thermodynamics relations.	1
3	able to **solve** problems of phase equilibrium.	3
4	able to **solve** problems of chemical equilibrium.	3

Course Title: Engineering Workshop

Course Code: ESC – 206

Theory: 01 Hrs / Week **Credits: 01**

Course Objective:

In workshop practice, students will get familiar with use of different workshop practices like fitting, welding, tin smithy, black smithy, foundry and computer hardware workshop. Students will also get familiar with different tools, machines, equipment, and job holding devices, job drawing, job material, job manufacturing operations and processes in different workshops.

Course Contents:

Unit - I

Manufacturing Methods: Casting: Pattern Making, pattern materials, pattern allowances, Types of sand. Moulding hand tools, defect in casting.

Forming: Hot working and Cold working, forging, Drawing, Rolling, Extrusion

Machining: Lathe machine, Its major parts & operations (5)

Unit – II

Joining: Welding: (Arc welding, TIG, MIG & Gas welding, types of flames), Brazing, riveting & fastening

Advance manufacturing methods: Electrical discharge machine(EDM), laser beam welding(LBM)CNC machining: Introduction.

Fitting operation: Marking, measuring, filling, drilling, tapping, Power tool: Power hacksaw machine, Bench grinder Machine. (5)

Unit – III

Carpentry: Timber, Measuring & Marking tools, cutting tools, planning tools, boring tools, striking tools, holding tools. Use of plastics & composites as engineering materials.

Plastic Moulding: Injection moulding.

Metal casting: die casting, its advantages &dis advantages, (5)

Text/Reference Books

1. ’Elements of Workshop Technology Vol I & Vol II: Hajara Chaudhari S. K, Hajara Chaudhari A. K, Nirjhar Roy S. K, Media promoters & publishers pvt. Ltd., Mumbai
2. Manufacturing Engineering & Technology: Kalpakjin S. & Steven S. Schmid, 4th addition

Pearson education India. Edition,2002

3. ’Manufacturing Technology: Gouri E. Hariharan & A. Suresh Babu, I Pearson education 2008
4. ’Processes & Material of manufacture’s: Roy A. Lindber, 4th edition, Prentice hall India 2008
5. Manufacturing Technologies I & II: Rao P. N. Tata McGraw-Hill house 2017

Course Outcome:

Upon successful completion of the course

CO No.	Course Outcome	Cognitive level
1	Students will gain knowledge of the different manufacturing processes which are commonly employed in industries, to fabricate components using different materials.	2

Course Title: Engineering Workshop Lab

Course Code: ESC – 206

Practical: 04 Hrs / Week **Credits: 02**

Workshop Practice: (Any Five)

1) Machine Shop: Turning- Facing, plain turning, Step turning & Taper turning.

2) Fitting: Filling, Drilling & Tapping

3) Carpentry: (Halving, Mortise & Tenon, Bridle, Butt, Dowel, Dovetail) any one.

4) Electrical & Electronics: Common house wiring connection

5) Welding Shop: (Butt, Lap, Corner, T) Any one

6) Piping (Any Joint)

7) Plastic Moulding: Injection moulding

Examination could involve the actual fabrication of simple components, utilising one or more of the techniques covered above.

Course Outcome:

Upon successful completion of the course

CO No.	Course Outcome	Cognitive level
1	Students will be able to **fabricate** components with their own hands.	6
2	They will also get practical knowledge of dimensional accuracies & dimensional tolerances possible with different manufacturing processes.	2
3	By assembling different component, they will be able to **produce** small devices of their interest.	6

Course Title: Transport Phenomena

Course Code: CHL-202

Theory: -3 Hrs./week + 1Hr. **Total Credits: - 4.0**

Course prerequisites: Mathematics

Course Objectives:

1. This course will highlight coupling between three transport phenomena with applications in various disciplines in engineering and science and will demonstrate to the students the common mathematical structure of transport problems.
2. The course will deal with flow problems involving Newtonian and non-Newtonian fluids, solid-state heat conduction, forced and free convection, binary diffusion with or without chemical reaction.

Course Contents:

UNIT I:

Introduction to Transport Phenomena, Formulation of transport problems from nature Vector and Tensor Analysis: Basic concepts (10)

UNIT II:

Basics of momentum transport: Euler/ Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor

Shell momentum balances, equations of change, dimensional analysis, applications to isothermal flow of Newtonian fluids. (10)

UNIT III:

Shell momentum balances: applications to flow of non-Newtonian fluids

Basics of energy transport, conductive, convective and viscous dissipation energy fluxes. Basics of mass transport, mechanisms and mass and molar fluxes (10)

UNIT IV:

Equations of change for non-isothermal systems, dimensional analysis, and applications to steady-state conduction and convection (10)

UNIT V:

Derivation of equation of continuity for a binary mixture and its application to convection diffusion

problems.

Unsteady-state momentum, heat and mass transport, formulation of basic equations and similarity transform method (10)

Text/Reference Books:

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot, “Transport Phenomena”, 2nd ed., Wiley India Pvt. Ltd., 2002.
2. Welty, C. E. Wicks, R. E. Wilson, and G. L. Rorrer, “Fundamentals of Momentum, Heat, and Mass Transfer”, 5th ed., Wiley India Pvt. Ltd., 2007.
3. W. M. Deen, “Analysis of Transport Phenomena”, Oxford University Press, 1998.
4. W. J. Thompson, “Introduction to Transport Phenomena”, Prentice Hall, 2000.

Course Outcomes:

Upon successful completion of the course

CO No.	Course Outcome	Cognitive level
1	Students would be familiarwithbasics of vector and tensoranalysis	2
2	Be able to **solve** transport problems using shellbalances	3
3	**Formulate** and solve one-dimensional transport problems by using the conservation equations	6
4	**Formulate** simple multi-dimensional transportproblem	6

Course Title: Constitution of India

Course Code: NC-202

Credit: Non-credit course

Course Objectives:

To percolate & disseminate knowledge about constitution of India for imbibing & understanding importance of fundamental rights & duties so as to aware the students towards justice, equality & liberty.

Course Content:

- **Introduction to the Indian Constitution:** History and Making of the Constitution, Constituent Assembly, Salient features, The preamble
- **Fundamental Rights & Duties:** Meaning and types of fundamental rights; Fundamental duties, the Right to Equality, the Right to Freedom, the Right against Exploitation, the Right to Freedom of Religion, Cultural and Educational Rights and Right to Constitutional Remedies

- **Directive Principles and Human Right:** Meaning of Directive Principles; difference between of Fundamental Rights and Directive Principles of State Policy – Implementation of Directive Principles of State Policy
- **Union Government & Administration:** Structure of Indian union, Loksabha, Rajyasabha, Powers and Functions of the President, the Prime Minister, Council of Ministers; composition, powers and functions of the Parliament, organisation of judiciary; jurisdiction of the Supreme Court; independence of judiciary, Election Commission

- **State Government & Local Administration:** Powers and Functions of Governor, Chief Minister and Council of Minister; composition, powers and functions of State Legislature, Local administration and constitution: Panchayati, Municipalities.

Course Outcome:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1.	**Understand** various constitutional rights &fundamental duties.	2
2.	**Understand** the implementation of Directive & Principles of State	2

	Policy.	
3.	Get **Knowledge** of powers and function of Central Government, Parliament, Supreme Court and Election commission.	2
4.	Get **Awareness** of powers & functions of Governor, State Government, Chief Minister and Council of Minister.	2

Suggested Books/ Readings:

1. M. V. Pylee – An Introduction to Constitution of India, Vikas Publications, New Delhi- 2005.
2. Subhash C. Kashyap – Our Constitution: An Introduction to India's Constitution & Constitutional Law, National Book Trust, New Delhi-2000.
3. Durga Das Basu – Introduction to the Constitution of India, PHI, New Delhi-2001.
4. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
5. J. C. Johari – Indian Government & Politics, Sterling Publishers, Delhi-2004.
6. V. D. Mahajan – Constitutional Development & National Movement in India, S. Chand & Company, New Delhi.
7. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
8. Granville Austin – Working of a Democratic Constitution: The Indian Experience, Oxford University Press, New Delhi-1999.
9. A. P. Avasthi – Indian Government & Politics, Naveen Agarwal, Agra-2004.
10. S. A. Palekar – Indian Constitution, Serials Publication, New Delhi-2003.

Semester-IV (Second Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-203	Heat Transfer	03	01	04	03	1.5	5.5
CHC-204	Fluid Mechanics	03	01	04	03	1.5	5.5
HML-202	Industrial Management and Economics	03	-	03	-	-	3.0
CHL-205	Chemical Process Technology	03	-	03	-	-	3.0
CHL-206	Material and Energy Balances Computations	03	01	04	-	-	4.0
Total Credit							**21**

Course Title: Heat Transfer

Course Code: CHC – 203

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Transport Phenomenon

Course Objective: The objective of this course is to provide basic knowledge of various modes of heat transfer and detail design knowledge of various heat exchangers and evaporators.

Course Contents:

Unit - I

Concept of heat transfer and transport of heat. Fourier's law, significance of thermal conductivity of solid, liquid and gases, heat transfer through plane and composite wall, sphere and cylinder, problem related to this case. Thermal diffusivity, differential equation of heat conduction, lagging of pipes and other equipment, optimum lagging thickness, critical radius of insulation. Heat Transfer from extended surfaces (fins). (10)

Unit – II

Convection: Individual and overall heat transfer coefficients, natural and forced convection, laminar and turbulent flow, significance of dimensional numbers, dimensional analysis and heat transfer analogy, flimwise and dropwise condensation (horizontal & vertical Surfaces). (10)

Unit – III

Design aspects of condensers reboilers and evaporators, Concept of Boiling and their types, Nussult Equation. Evaporation: Single and Multiple effect evaporator. B.P.R. and hydrostatic head. Economy and capacity of evaporator. Problem based on single effect evaporator. (10)

Unit – IV

Radiation: Laws of radiation, radiation from solid surfaces, types of surfaces. Heat exchange by radiation between two finite black surfaces, between two infinite parallel surfaces, shape factor. Laws of shape factor, solid angle and radiation intensity, Green House effect. Electrical analogy of radiation shield. (10)

Unit – V

Heat Exchangers: classification, overall heat transfer coefficient, fouling factor, LMTD in single pass parallel, counter and cross flow arrangements. N.T.U.- effectiveness method for parallel and counter flow heat exchangers, general design aspect of heat exchangers. Problem based on LMTD and NTU effectiveness method. (10)

Text/ Reference Books

1. Holman,J..P.,S. Bhattacharya, Heat Transfer,10th edition, Tata McGraw-Hill,2011.

2. D.Q.Kern, Process heat transfer, Tata-McGraw Hill,1997.
3. R.Welty, C.E. Wicks, R.E.Wilson, G.Rorrer, Fundamentals of Momentum, Heat and Mass Tranfer, 4th edition, Wiley,2007.
4. W.J.Mccabe, J.Smith, P.Harriot, Unit Operations of Chemical Engineering, 6th edition, McGraw Hill, 2005.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understands** the various modes of heat transfer.	2
2	**Understands** the basics of fins.	2
3	**Design** double pipe heat exchanger, shell and tube heatexchanger.	6
4	**Design** single effect evaporator.	6

Heat Transfer Lab

Course Code: CHC-203 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Contents:

1. To determine the heat transfer coefficient of air by using natural convection.
2. To determine the Stefan Boltzmann constant for radiation.
3. To determine the thermal conductivity of metal bar.
4. To determine the thermal conductivity of liquid (Lubricating oil).
5. To determine the heat transfer coefficient of double pipe finned tube heat exchanger.
6. To determine the log mean temperature difference in double pipe heat exchanger for parallel flow arrangement.
7. To determine the log mean temperature difference in double pipe heat exchanger for counter flow arrangement.
8. To Study the drop-wise and film-wise condensation.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Enhance the knowledge and clear the theoretical concepts of heat transfer by performing the hands-on experiments in the laboratory for detail understanding of the topic.	2

Text/ Reference Books

1. Holman,J..P.,S.Bhattacharya, Heat Transfer,10th edition, Tata McGraw-Hill,2011.
2. D.Q.Kern, Process heat transfer, Tata-McGraw Hill,1997.
3. R.Welty, C.E. Wicks, R.E.Wilson, G.Rorrer, Fundamentals of Momentum, Heat and Mass Tranfer, 4th edition, Wiley,2007.
4. W.J.Mccabe, J.Smith, P.Harriot, Unit Operations of Chemical Engineering, 6th edition, McGraw Hill, 2005.

Course Title: Fluid Mechanics

Course Code: CHC-204

Theory: 04 Hours/week (Teaching Hours: 03, Tutorial: 01) **Total Credits: 04**

Pre-requisites: Transport Phenomena

Course Objectives

The objective of this course is to make student well acquainted with different concepts in fluid mechanics like fluid statics, kinetics, dynamics, hydrostatic forces on submerged bodies, flow through pipes, instruments for flow & pressure measurement, types of flows, boundary layer theory, dimensional analysis & transportation of fluids by pumps, blowers and compressors etc& their applications particularly in chemical engineering.

Course Contents:

UNIT I

Concept of Fluid, Properties of Fluids, Viscosity, Newton's Law of Viscosity, Types of Fluids, Measurement of Pressure, Fluid Pressure at a Point, Pascal's Law, Hydrostatic Law, Absolute, Gauge, Atmospheric & Vacuum Pressures, Measurement of Pressure, Simple Manometers, Differential Manometers, Total Pressure & Centre of Pressure for a Vertical, Horizontal Surface Submerged in Liquid, Buoyancy, Centre of Buoyancy, Stability of Floating & Submerged Body.

Problems Based on All the Topics in a Unit. (10)

UNIT II

Kinematics of Flow: Types of Fluid Flows, Continuity Equation, Continuity Equation in Three Dimensions, Continuity Equation in Cylindrical Polar Coordinates, Velocity & Acceleration Concept, Stream Functions, Potential Flow & Its Important Cases.

Dynamics of Flow: Euler's Equation, Bernoulli's Equation, Applications of Bernoulli's Equation (Venturi Meter, Orifice Meter, Pitot Tube), Rotameter, Notches & Weirs.

Problems Based on All the Topics in a Unit. (10)

UNIT III

Flow Through Pipeline System: Loss of Energy in Pipes, Laws of Friction, Major Losses & Minor Losses, Loss of Head Due to Friction in Pipes (Darcy-Weisbach Formula), Chezy's Formula, Water Hammer in Pipes, Hydraulic & Total Energy Line.

Viscous Flow: Flow of Viscous Fluid through Circular Pipe (Hagen Poiseuille Formula), Between Two Parallel

Plates, Methods of Determination of Coefficient of Viscosity, Kinetic Energy & Momentum Correction Factor.

Turbulent flow: Reynolds Experiment, Velocity Distribution in Turbulent Flow in Pipes, Hydrodynamically Smooth & Rough Boundaries, Velocity Distribution for Turbulent Flow in Smooth & Rough Pipes, Velocity Distribution for Turbulent Flow in Terms of Average Velocity, Variation of Friction Factor.

Problems Based on All the Topics in a Unit. (10)

UNIT IV

Dimensional Analysis: Fundamental Dimensions, Methods of Dimensional Analysis, Rayleigh's Method, Buckingham's π Theorem, Types of Similarities, Types of Forces Acting on Moving Fluid, Dimensionless Numbers, Classification of Models.

Boundary Layer Theory: Laminar & Turbulent Boundary Layer, Boundary Layer Thickness, Displacement Thickness, Momentum Thickness, Energy Thickness,Drag Force on a Flat Plate Due to Boundary Layer, Separation of Boundary Layer, Methods of Preventing Separation of Boundary Layer.

Problems Based on All the Topics in a Unit. (10)

UNIT V

Pumping of Liquids: Classification of Pumps, Principle, Construction, Working, Design, Discharge, Work Done & Power Requirement by Centrifugal Pump, Reciprocating Pump (Single & Double Acting), Pumps in Series, Pumps in Parallel, All Curves for Centrifugal Pump, Pump Efficiencies, Selection of Pumps, Priming, NPSH, Cavitation.

Pumping of Gases: Classification of Compressors, Principle, Construction, Working, Design, Discharge, Work Done & Power Requirement by Centrifugal & Reciprocating Compressor, Blowers, Vacuum Pump.

Problems Based on All the Topics in a Unit. (10)

Text/Reference Books

1. M. White, Fluid Mechanics, 8th Edition, Tata-McGraw Hill, 2016.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill International Edition 2005.
4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.

5. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.
6. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed.,Wiley (2007).
7. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, 6th Edition, Wiley-India 2010.
8. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley India 2002.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The students will have thorough knowledge of fluid properties, behaviour of fluid under different conditions, hydrostatics & pressure measurement.	2
2	The students will get well acquainted with basic principles in kinematics & dynamics of fluid flow with its application.	2
3	It will clear the basic concepts about various types of flows, complexities in flow through pipeline systems with detail study of laminar, turbulent flow.	2
4	Students will get well acquainted with phenomena of boundary layer formation and separation. Students will be able to understand dimensional analysis and its application to **solve** the complex problems in heat & momentum transfer.	3
5	Student will have thorough knowledge of handling of fluids by various pumps, compressors, blowers and will be able to **design** the fluid handling system with calculation of power requirement in it. It will enhance the ability of students to identify and solve various engineering problems.	6

Fluid Mechanics Lab

Course Code: CHC-204 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Objectives:

To impart practical knowledge of fluid mechanics to students.

Course Contents:

1. To Study Reynold's Experiment.
2. To Study different types of Manometers.
3. To Verify Bernoulli's Theorem
4. To Determine Coefficient of Discharge for Venturimeter.
5. To Determine Coefficient of Discharge for Orificemeter.
6. To Determine Coefficient of Discharge for Rectangular, Triangular & Trapezoidal Notch or Weirs.
7. To Determine the Viscosity of Oil Using Ostwald's Viscometer.
8. To Determine the Viscosity of Oil Using Stoke's Law.
9. To Determine Loss of Head Across Various Pipe Fittings.
10. To Study Different Types of Pumps & Compressors.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Enhance the practical knowledge and clear the theoretical concepts in the subject by performing hands on experiments in the laboratory for detail understanding of the topic.	2

Text/ Reference Books

1. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
2. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill International Edition 2005.
3. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.
4. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition,

Wiley-India 2010.

Course Title: Industrial Management and Economics

Course Code: HML-202

Theory: 03 Hours/week **Total Credits: 03**

Course Prerequisite: Basic Manufacturing Process, Principle of Economics

Course Objective

1. Identification and selection of management & administration with aspect towards the Production planning and management.
2. Understanding Micro and Macroeconomics Demand and Supply factors of market economy &institutional feature inside the organisation as well as outside the organisation.
3. Understanding GDP statement, Entrepreneurship Development

Course Content

Unit-I

Management: Introduction & meaning management & administration
Industrial management: Connotation of Industrial management
Organisation: Explication and Types of organisation
Manufacturing system: definition, class of manufacturing system
Plant layout: Classification of Plant layout (8)

Unit-II

Business organization: Forms of business organization
Productivity: Various techniques to increase Productivity Sound
wage program: Mechanics of sound wage program
Wages & Wage Administration: Introduction &meaning of Wages & Administration of remuneration

(8)

Unit-III

Marketing management: Introduction meaning and Concept of marketing management
Concept Sales management: Introduction meaning and Concept of Sales management significance of Sales management
Functions of Marketing management: prominence of marketing management

Functions of Sales management, role of Sales management (8)

Unit-IV

Economics: Introduction, meaning of Economics

Concept of GDP: Introduction meaning and Concept of GDP

Concept of ADP: influence of ADP

Introduction of Micro economics and Macro economics

Difference between Micro economics and Macroeconomics (8)

Unit-V

Entrepreneurship: Introduction, meaning and Concept of Entrepreneurship,

Types of Entrepreneurship: Order of Entrepreneurship

Entrepreneurship Development (8)

Text/ References Books:

1) John R. Hicks, "Value and Capital", 10th edition, Oxford, Clarendon Press, 2017
2) R. R. Barthwal, "Industrial Economics: An Introductory Text Book", 11th edition, New Age International, 2015
3) Martin Ricketts, "The Economics of Business Enterprise", 5th edition, ELGAR International, 2019
4) H. L. Ahuja, "Modern Economics" 9th edition, S. Chand Publishing, 2016
5) Alfred Marshal, "principle of Economics", 15th edition, Prometheus Books, 2016.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Understanding of management and Productivity aspect towards the material management Production planning. Processes/operations according.	2
2	Identification, selection and understanding the meaning and utility of Marketing management, consumer satisfaction, sales and advertising.	2
3	Understand the importance of Entrepreneurship Development.	2

Course Title: Chemical Process Technology

Course Code: CHL-205

Theory: 03 Hours/week **Total Credits: 03**

Pre-requisites: Basic Chemistry

Course Objective

To impart the thorough knowledge of industrial process technologies for the manufacturing of various organic and inorganic chemicals and to get the students well acquainted with various process industries.

Course Content

Unit I

Salient features of manufacturing commodity chemicals, status of chemical industry in India, classification & characterization of chemical industries, current trends in chemical industry. Treatment for industrial use, sources of impurities, methods of softening, treatment for boiler feed water.(8)

Unit II

Engineering aspects of manufacturing of basic inorganic chemicals such as sulphuric acid, caustic soda, soda ash, chlorine, ammonia, nitric acid and urea. (8)

Unit III

Introduction to petrochemicals, crude types and properties, concept of onshore and offshore drilling, desalting of crude and feed preparation. Physical & chemical properties of petrochemicals, classification of petrochemicals. (8)

Unit IV

Fluidized bed and catalytic cracking, thermal and hydrocracking, reforming, alkylation, isomerization, polymerization of petrochemicals, study of linear alkyl benzene, aromatic compounds, and separation techniques. (8)

Unit V

Engineering aspect of the manufacture with alternative routes for basic organic chemicals such as aldehydes, ethylene, other olefins, acetylene, butadiene, phenols, amines, alcohols, carboxylic acids, esters, ketones, and ethylene oxides. Classification, sampling, analysis and selection of coal, carbonization and complete gasification of coal. (8)

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	To enhance the ability of students to understand the manufacturing of various inorganic and organic chemicals.	2
2	To get the students well acquainted with concept of onshore and offshore drilling, manufacturing and treatment processes of various petrochemicals.	2
3	To enhance the ability of students to understand the process flow diagram and various processparameters.	2
4	To enhance the ability of students to identify and solve engineering problems during production.	3
5	To get the students well acquainted with water treatmentprocesses.	2

Text Books

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997
3. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005
4. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013
5. Chemical Process Technology, Moulijn, M. and van Dippen, Wiley, 2013

Course Title: Material and Energy Balance Computations

Course Code: CHL-206

Theory: 04 Hours/ week (Teaching Hours: 03, Tutorial: 01) **Total Credits: 04**

Course Prerequisites: Physics, Chemistry-I, Mathematics-I, Thermodynamics-I

Course Objectives:

1. To teach students fundamental knowledge of chemical engineering and application of this knowledge in the solving of material and energy balances of chemical processes.
2. The course will cover concepts ranging from basics such as units and dimensions, stoichiometry to the simultaneous application of material and energy balances with and without occurrence of chemical reaction.

Course Contents:

UNIT- I

Units and Dimensions: Basic and derived units, different ways of expressing units of quantities and physical constants.

Calculations for mole, molecular weight, equivalent weight, etc., Composition of gaseous mixtures, liquid mixtures, solid mixtures, etc., Ideal gas law & other equations of state and their applications, Dalton law, Raoult's law, Hess's Law, Henry's law, Solutions and their properties. (10)

UNIT-II

Stoichiometry and unit operations:

Introduction to unit operation, development of block diagram and material balance for unit operations like blending, evaporation, crystallization, extraction and leaching, distillation, absorption & stripping, drying etc. (10)

UNIT-III

Material balance involving chemical reaction:

Introduction, definition and concept of terminologies like Excess Reactant, Conversion, Yield, Selectivity. Problems on material balance for chemical reactions for calculation of feed composition and product composition, Conversion, Yield, Selectivity etc. (10)

UNIT-IV

Humidity: Terminologies of Humidification like Humid Heat, Humid volume, % saturation, Molal Humidity, Molal saturation, absolute humidity etc.

Energy balance: Enthalpy calculation for systems (single component and multi components) without Chemical Reaction with Mean and Temperature Dependent Heat Capacity, Enthalpy calculation for systems with Chemical Reactions. Heat of Reaction from Heat of Formation and Heat of Combustion Data, Effect of Temperature and Pressure on Heat of Reaction. (10)

UNIT-V

Introduction to Recycle, Bypass and purge operations: Applications of Recycle, Bypass and purge operations in unit operations and processes for calculation of recycle ratio, purge ratio, combined feed ratio.

Fuels: Types of fuels, Calorific value of fuels, Problems on combustion of coal, liquid fuels, gaseous fuels, etc., Proximate and ultimate analysis, Combustion calculations, Air requirement and flue gases. (10)

Text/ Reference Books:

Author, name of Book, latest edition year, publication

1. Bhatt., B.I. and Vora S.M."Stoichiometry*"* IInd edition, Tata McGraw Hill.
2. O.A. Hougen, K.M. Watson and R.A. Ragatz "Chemical Process Principles" Part-I,CBS Publishers & distributors ,New Delhi.
3. K.A.Gavhane "Introduction to process calculations" Nirali Publications.
4. Shekhar Pandharipande and Samir Musharaf "Process Calculations" Pune Vidyarthi GrihaPrakashan, Pune.
5. Himmelblau, D.M. ″Basic Principles and Calculations in Chemical Engineering″, 6th edition. Prentice Hall.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The capability to convert units and dimensions and **modify** equations from system to another.	6
2	The capability to **apply** the laws of physics and chemistry in solving process industry related applications.	3
3	The proficiency to **integrate** the data and **formulate** the mass and energy balance problems.	6
4	The capability to use mathematical knowledge for **solving** mass and energy balance problems with and without chemical reactions.	3

Syllabus of Third Year
B. Tech. (Chemical Engineering)

(Revised Syllabus w. e. f. 2020-21)

Faculty of Science and Technology

University Institute of Chemical Technology

Kavayitri Bahinabai Chaudhari

North Maharashtra University,

Jalgaon

(Academic Year 2020 – 21)

Third Year B.Tech.(Chemical Engineering)

Revised Syllabus w.e.f. 2020-21

Semester-V

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-307	Particle & Fluid Particle Processing	03	-	03	03	1.5	4.5
CHC-308	Mass Transfer – I	03	01	04	03	1.5	5.5
CHC-309	Chemical Reaction Engineering – I	03	01	04	03	1.5	5.5
HML-309	Psycho-Social Dimensions of Industrial Management	03	-	03	-	-	3.0
Elective–I	Open Elective	03	-	03	-	-	3.0
CHC-310	Numerical Method in Chemical Engineering	02	-	02	02	01	3.0
NC-303	Essence of Indian Traditional Knowledge	-	-	-		NC	NC
Total Credit							**24.5**
Semester-VI							
Course Code	**Course Title**	**Teaching Hours**	**Tutorial**	**Credits**	**Practical Hours**	**Credits**	**Total Credits**
CHC-311	Chemical Reaction Engineering – II	03	01	04	03	1.5	5.5
CHL-312	Process Design and Project Management	03	-	03	-	-	3.0
CHC-313	Mass Transfer–II	03	01	04	03	1.5	5.5
Elective II	Open Elective	03	-	03	-	-	3.0
Elective III	Professional Elective Courses	03	-	03	-	-	3.0
Total Credit							**20.0**

List of Electives

Elective I (Open Elective)

FTL-305 Advanced Technology in Food Packaging

OTL-305 Technology of Perfumery and cosmetics

PTL-305 Specialty Pigments and Additives in Coatings

PLL-304 Polymer Rheology

CHL-320 Nanoscience and Nanotechnology

Elective II (Open Elective)

FTL-306 Treatment and Disposal of Food Industrial Waste

OTL-306 Biochemistry & Biotechnology of Lipids

PTL-306 Technology of Printing Inks

PLL-305 Plastics Waste Management

CHL-321 Water Conservation and Management

Elective III (Professional Core Elective)

CHL-322 Environmental Pollution and Control

CHL-323 Petroleum Refining Engineering

Course Title: Particle and fluid particle processing

Course Code: CHC-307

Theory: 03 Hours/ week (Teaching Hours: 03, Tutorial: 00) **Total Credits: 03**

Course Prerequisite: Material and energy balance computations, Fluid Mechanics Course

Course Objectives:

The objective of this course is to make student well acquainted with basic principles of various operations used for fluid particle processing, construction and working of the equipment.

Course Contents:

UNIT- I

Properties & Handling of Particulate Solids: Particle size, shape; mixed particle size & size analysis, specific surface of mixture, average particle size; properties of particulate masses; storage of solids. Size Reduction: Law of crushing, Size reduction equipment for coarse, intermediate & fine size reduction; Numerical based on energy & power requirement; open & closed loop circuit.

UNIT - II

Screening: Equipment, ideal calculation of effectiveness of screen. Screen analysis methods & std. screen series; capacity of screen; Mixing of Solids & Pastes: Mixers for coasive solids, free flowing solids, paste & plastic masses, power requirement, mixing effectiveness by mixing index, Numerical for mixing index. Mixing & Agitation of Liquids: Agitation equipment & flow pattern; circulation velocities & power consumption in agitated vessel; blending & mixing.

UNIT -III

Flow Past Immersed Bodies: Drag coefficient, Stokes law, Cozeny- Carman equation. Flow of Solids Through Fluids: Calculation of terminal settling velocity for various Re Number region, maximum settling velocity, free & hindered settling conditions. Fluidization: Minimum fluidization velocity, types of fluidization, application of fluidization such as catalytic cracking, drying, etc.; Relation between pressure drop gradient with fluidizing velocity.

UNIT - IV

Classification & Sedimentation: Clarification & thickening, separation ratio; equipment for centrifugal & gravity classification; cyclone separator & design; hydrocyclones; principle of jigging, tabling,

magnetic & electrostatic separation. Gravity sedimentation; laboratory batch & continuous sedimentation, centrifugal sedimentation.

UNIT -V

Filtration: Filter aids, classification of filters, selection of filter media. Principle of batch filtration: constant pressure & constant rate filtration, factors affecting filtration. Continuous, centrifugal, vacuum, gravity filtration & related equipment. Washing of filter cake.

Reference Books:

1. Mc Cabe W. L. & Smith J. C. " Unit Operation for Chemical Engineering." 5th Edition.
2. Coulson J. M. &Rechardson J. F. " Chemical Engineering. - Vol. II"
3. Badger W. L. &Banchero J. T. " Introduction to Chemical Engineering."
4. Narayan &Bhatacharya " Mechanical Operation in Chemical Engineering."
5. P. Chattopadhaya " Unit Operation in Chemical Engineering. Vol. I "
6. G. G. Brown " Unit Operations"

Course Outcomes:

After learning the course, the students should be able

1. To **review** the practical importance and relevance of unit operations used for crushing, grinding and size separation in chemical industry.
2. To **define** the properties of solid and to select suitable size reduction equipment.
3. To **analyze** mixing processes solid-solid separation method.
4. To **analyze** solid liquid separation process and fluid particle system.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	To **review** the practical importance and relevance of unit operations used for crushing, grinding and size separation in chemical industry.	2
2	To **define** the properties of solid and to select suitable size reduction equipment.	1

3	To **analyze** mixing processes solid-solid separation method.	4
4	To **analyze** solid liquid separation process and fluid particle system.	4

Particle and fluid particle processing Lab

Course Code: CHC-307 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Contents:

1. Study of the properties of solid.
2. Calculation of critical speed of ball mill and grinding of given sample.
3. Calculation of power consumption for crushing operation in Hammer mill.
4. Study of relationship between drag coefficient and modified Reynolds number for spherical body falling through fluid for Stokes law region.
5. Study of Batch sedimentation process.
6. Calculation of efficiency of cyclone separator.
7. Study of sigma mixture.
8. Study of filtration process in basket centrifuge.

Reference Books

1. Mc Cabe W. L. & Smith J. C. " Unit Operation for Chemical Engineering." 5th Edition.
2. Coulson J. M. &Rechardson J. F. " Chemical Engineering. - Vol. II"
3. Badger W. L. &Banchero J. T. " Introduction to Chemical Engineering."
4. Narayan &Bhatacharya " Mechanical Operation in Chemical Engineering."
5. P. Chattopadhaya " Unit Operation in Chemical Engineering. Vol. I "
6. G. G. Brown " Unit Operations"

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Ability to **calculate** the properties of solid.	4
2	**Analysis**of the performance of size reductionequipment.	4
3	Ability to **analyze**separation process for solid liquid system and Gas solidsystem.	4

Course Title: Mass Transfer – I

Course Code: CHC – 308

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Transport Phenomena

Course Objective:

Objective of this subject is to expose students to understand the basic mass transfer operation like diffusion, absorption, drying, humidification and its application to chemical engineering

Course Contents:

Unit - I

Constitutive laws of diffusion; unsteady state diffusion, equimolecular counter diffusion, diffusion in stationary gas. Diffusivities in liquid, vapor and gases. Maxwell's law of diffusion, mass transfer velocities, thermal diffusion.

Unit – II

Interphase mass transfer process - Mass transfer theories/models, Mass transfer and chemical reaction. Dimensional analysis in mass transfer and analogies. Local and average overall mass transfer coefficients, mass transfer correlations. Simultaneous heat and mass transfer.

Unit – III

Absorption: Solubility, choice of solvent, concept of rate approach and stagewise approach, Rate of absorption and mass transfer coefficient, steady state co current and counter current processes: stage wise and differential contacts. Stage efficiency, Number of theoretical stages.

Material balance for transfer of one component - minimum liquid-gas-ratio for absorber. Absorption with & without chemical reaction. Determination of height of columns, transfer units (NTU, HTU) and HETP.

Unit – IV

Gas–Liquid operations - Sparged vessels (bubble columns), mechanically agitated vessels for a single phase and gas liquid contact. Liquid dispersed scrubbers, venturi scrubbers, wetted towers packed towers.

Packed towers: General construction & working, types of packing merits & demerits, operational difficulties, pressure drop & limiting G-L flow rates.

Plate towers: General construction & working, types of plate, merits and demerits, operational difficulties.

Unit – V

Humidification: Wet bulb, dry bulb and adiabatic saturation temperatures, humidification terms and usage of psychometric chart, humidification & dehumidification methods, design procedures and selection criteria along with mass transfer calculations. Types of cooling towers, cooling tower operational characteristics. Drying: Drying mechanism, drying rate curves, estimation of drying time, moisture contents. Drying equipment's- rotary dryers, drum dryers, vacuum dryers, Spray dryer, fluidized bed dryers.

Text/ Reference Books

1. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977
2. J. D. Seader and E. J. Henley, Separation Process Principles, Second Edition, Wiley Asia Student Edition.
3. A. L. Hines, R. N. Medox, Mass Transfer: Fundamental and Application.
4. B. K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India,2007
5. R. E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
6. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
7. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of ChemicalEngineering, 7th Edition, Tata McGraw Hill, India, 2014.
8. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition,Prentice Hall, India, 1993.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Recognize** laws of diffusion; **apply** them in mass transfer operation.	1
2	**Analyze** inter phase mass transfer operation and its design aspects.	4
3	**Understand** the fundamentals of gas absorption and **estimate** the number of stages in absorption column.	2

4	**Evaluate** drying rates and moisture content for drying operation and design approach to dryers, cooling towers and humidifiers.	5

Mass Transfer – I Lab

Course Code: CHC-308 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Objectives:

To provide the hand-in-hand experience of lab-scale experiments on various types of equipment based on the theoretical understanding and its application learned in theory course.

Course Contents:

1. Determination of diffusivity of acetone in air
2. Determination of diffusivity of naphthalene in air.
3. Determination of diffusivity of Acetic acid in water.
4. Determination of rate of drying of given sample
5. Determination of Mass transfer coefficient in wetted wall column.
6. Determination of humidity of air using of psychometric chart.
7. Study the physical absorption in packed bed (HTU/NTU/HETP)
8. Determination of loading and flooding point in packed column.
9. Study Absorption of CO_2 in alkaline solution.

Text/ Reference Books

1. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977
2. J. D. Seader and E. J. Henley, Separation Process Principles, Second Edition, Wiley Asia Student Edition.
3. A. L. Hines, R. N. Medox, Mass Transfer: Fundamental and Application.
4. B. K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India,2007
5. R. E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
6. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
7. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of ChemicalEngineering, 7^{th} Edition, Tata McGraw Hill, India, 2014.
8. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition,Prentice Hall, India, 1993.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Develop** the ability regarding analytical and data interpretation skills.	6
2	**Understand** the scaling approach of understanding from Experimental to Industry applications.	2
3	**Plan** an appropriate approach to experiment work and **justify** plans in the light of preliminary findings.	4
4	**Demonstrate** safe working in the choice of method and apparatus.	2

Course Title: Chemical Reaction Engineering-I

Course Code: CHC-309

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Material and Energy Balance calculations

Course Objective:

1. This course will highlight basic concepts of kinetics and rate laws along with interpretation of rate data.
2. The course will deal with problems involving design & rating of ideal reactors including heat effects, multiple reactions and analysis of non-ideal flow behaviour in the reactors.

Course Contents:

UNIT I:

Reactions and reaction rates - stoichiometry, extent of reactions, conversion, Selectivity

Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory.

UNIT II:

Analysis and correlation of experimental kinetic data - data collection & plotting, linearization of rate equations, differential and integral method of analysis.

UNIT III:

Ideal reactors - generalized material balance, design equations, graphical interpretation.

Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors – solving design equations for constant and variable density systems, reactors in series and parallel.

UNIT IV:

Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series- parallel reactions.

UNIT V: A: RTD theory and analysis of non-ideal reactors.

Text/ Reference Books

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall 2001.

2. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons 2001

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Design** chemical reactors involving heat effects optimally using minimum amount of data	6
2	**Understand**&**Interpret** Kineticsdata.	2
3	**Operate**reactors in a safe manner for single and multiplereactions	3
4	**Analyze**the non-ideality in thereactors	4

Chemical Reaction Engineering-I Lab

Course Code: CHC-309 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Objectives:

1. This laboratory course provides students, experimental skills of kinetics and rate laws along with interpretation of rate data.
2. The course will deal with experiments involving design & rating of ideal reactors including heat effects.

Course Contents:

1. To study the Rate Law K Determination
2. To study the Rate Law n order
3. To study the Semi Batch Reactor.
4. To study the CSTR – Effect of Volume.
5. To study the CSTR – Effect of Flow Rate.
6. To study the PFR – Effect of Flow Rate.
7. To study the Fluid Bed Reactor.
8. To study 2^{nd} Order Reaction Analysis.
9. To study Reactor in Series.
10. To study the Recycle Reactor

Text/ Reference Books

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall 2001.
2. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons 2001

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Design** chemical reactors involving heat effects optimally using minimum amount of data	6
2	**Understand** &**Interpret** Kinetics data.	2
3	**Operate** reactors in a safe manner for single and multiple reactions	3

Course Title: Psycho-Social Dimensions of Industrial Management

Course Code: HML – 309

Theory: 03 Hrs / Week **Credits: 03**

Course Objective:

1. To prepare and develop the students for successful career that meets the global Industrial and Corporate requirements.
2. To guide the students about perception and attitude development to excel in organisation setting
3. To provide an environment for students to work on Multidisciplinary projects as part of different teams to develop their team building capabilities like leadership, motivation, teamwork etc.
4. To introduce professional ethics and codes of professional practices in Industry.

Course Contents:

Unit - I

Concept and meaning of organisationbehaviour, features & foundations of organisationbehaviour, the role of organisationbehaviour, theories of organisationbehaviour, the behaviour process, innovation & creativity in organization.

Unit – II

Perception: meaning and definition, factors influencing the perception process, perception process, perception and Individual decision making, nature of attitudes, components of attitude, formation of attitudes, functions of attitudes, work related attitudes: job satisfaction &organisational commitment, attitudes, values &organisationbehaviour.

Unit – III

Motivation-nature & Importance, Theories of Motivation, Content Theories and Process theories-evaluation & criticism, self-motivation.

Unit IV

Leadership- Nature, Leadership and management, Importance, leadership styles and their implications, trait and behavioural approach of Leadership, decision making-nature, types

&conditions of decisions, decision making process & styles.

Unit IV

Nature and sources of ethics, ethical dilemmas, resolving dilemmas, ethical decision making, ways of managing ethics, corporate social responsibility.

Text/Reference Books

1. OrganisationalBehaviour –K Aswathapa- Himalaya Publishing House
2. Organizational Behaviour – John Martin- International Thomson Business press
3. Organisationalbehaviour- Mirza S Saiyadain-tata Mcgraw-Hill publishing Co. Ltd
4. OrganisationalBehaviour –MN Mishra Vikas Publishing House Pvt Ltd
5. OrganisationBehaviour- Stephen Robbins-Pearson Publication
6. Management- 6th edition- James A.F.Stoner- Pears Education

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Develop** the process of individual behaviour and perpetual process along with conditioning of thinking process	6
2	To **identify** the concept and process of motivation and leadership	2
3	**Correlate** human behaviour, social skills, innovations, and creativity to improve workplace dynamics.	4
4	**Develops** the knowledge of ethical considerations and administrative regulations by applying the theories and principles of Management in practice to improve performance of individual employee at a workplace.	6

Course Title: Advanced Technology in Food Packaging (Open Elective-I)

Course Code: FTL-305 (Open Elective-I)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

1. To study basic packaging materials, their properties, types of packaging, sealing and lamination process.
2. To study newer packaging technologies used for food products.
3. To estimate shelf life of packaged products.
4. To study packaging of soft drink and alcoholic beverages.

Course Contents:

Unit I:

Packaging as a method for conservation and protection of foods, different packaging material and their properties including barrier properties, strength properties, optical properties etc. Glass, Aluminium, tin, paper, plastic and composites. Sealing of metallic and plastic containers. Types of food packaging.

Unit II:

Flexible packaging, laminated packaging and retortable pouches and biodegradable packaging material. Concept and calculation of shelf life of laminate, wine in PET, glass bottle; shelf life based on browning, vitamin loss and microbial count in food container. Safety and testing of packaging containers.

Unit III:

Active packaging system: - Packaging requirement for different moisture level food products, Aseptic processing and packaging of fruits & vegetables, milk and milk products.

Unit IV:

Product- Package compatibility: - Microwavable Packaging, MAP of fresh fruit and vegetable, vacuum and MAP of meat and meat products. Packaging of breakfast cereals, bakery and confectionary products.

Unit V:

Packaging of soft drink, alcoholic beverages, distilled spirits, frozen food, future trends in food packaging: intelligent/ smart packaging.

Text/Reference Books:

1. Handbook of food packaging by F. A Paine and H.Y paine., Publisher: Blackis and Son Ltd London (1983)
2. Food Packaging Principles and Practice: Gordon L. Robertson
3. Modern processing and distribution system for food edited by F. A Paine
4. Food and packaging interaction by Risch. S. H., Publisher: American chemical Society, Washington (1991)
5. Packaging materials and containers by Paine . F. A., Publisher: Blackis and sons Ltd, London (1983)
6. Food packaging and preservation: theory and practice by Mathlauthi: M. Publisher
7. Packaging media by Paine F. A., Publisher: Blackis and son Ltd; Bishop Briggs (1977)
8. Food packaging technology (vol. 1.92) by G. Bureau and J. L. Multon., Publisher: Veh New York (1996)
9. Chemistry of Food Packaging by Swalam C.M., American Chemical Society, Washington D. C. 1974.
10. Packaging by Neubaner R.G. Van Nostrand Co. New York.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students will be able to **recognize** and **classify** food packaging materials and their use.	1
2	Students will be able to **differentiate**, Active packaging, Aseptic packaging, MAP, vacuum packaging, smart packaging.Microwavable packaging.	2
3	Students will be able to **estimate**of Shelf life of foodpackaged.	2
4	Students will be able to **state**Packaging of, soft drink, alcoholic beverages, frozenfood.	2

Course Title: Technology of Perfumery and Cosmetics (Open Elective-I)

Course Code: OTL– 305 (Open Elective-I)

Theory: - 3 Hrs./week . Total Credits: - 3.0

Course objectives: This course provides a thorough knowledge about different essential oil, perfumery synthetics and cosmetic ingredients. Students shall acquire various extraction methodologies in recovery of essential oils, their physio-chemical properties and applications. Also, the course will cover raw material for different cosmetic preparations.

Course Contents:

Unit I:

Essential oils: Chemistry, source materials, production methods

Production, properties and applications of essential oils (Rose, Jasmine, Khus, Sandalwood, Palmarosa, Lemongrass, Peppermint, Orange).

Unit II:

Physio-chemical properties of essential oils: Colour, specific gravity, refractive index, optical rotation, solubility, congealing point, evaporation residue, acid value and ester value.

Analysis of essential oils: Alcohol, Aldehyde, Ketones and Phenol content.

Unit III:

Grading and standardization of essential oils; common adulterants and their detection.

Perfumery: History and its function, mechanism of smelling, classification & blending of perfume ingredients, perfumery isolates (Menthol, Geraniol and Musk).

Unit IV:

Synthetic perfumery materials and fixatives (Camphor, Thymol, Citral, Vanillin, Cumarin, Benzyl acetate, Benzyl benzoate)

Production, properties and applications: Hair oil & dyes, Shaving creams and Depilatories.

Unit V:

Production, function and properties of cosmetic products: Face cream, Face powder, Talcum powder, Toothpaste/powder, Shampoo, Lipsticks and Nail polish.

Text/Reference Books:

1. Valerie Ann Worwood "The Complete Book of Essential Oils and Aromatherapy"
2. Ernest Guenther"The Essential Oils" Volume-I
3. Sonia Malik "Essential Oil Research" Springer International Publishing
4. "Hand Book of Perfumes with Formulations" Engineers India Research Institute.
5. Nigel Groom"The Perfume Handbook" Springer
6. Steffen Arctander"Perfume and Flavor Materials of Natural Origin"
7. S.K. Singh "Handbook on Cosmetics (Processes, Formulae with Testing Methods)"
8. H. W. Hibbott. "Handbook of Cosmetic Science" 1st Edition

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the fundamental of essential oils and **propose** methods of their production.	2
2	**Differentiate** the principles behind the physio-chemical analytical techniques in the estimation of quality parameters of essential oils.	2
3	**Devise** the concepts of perfumery, blending of perfumes and **outline** the use of synthetic perfumery materials.	6
4	**Propose** the production techniques and **illustrate** the functions of ingredients in cosmetics products.	6

Course Title: Specialty Pigments and Additives in Coatings (Open Elective-I)

Course Code: PTL-305 (Open Elective-I)

Theory: - 3 Hrs./week . Total Credits: - 3.0

Course objectives:

The Paint Technocrat will have in depth exposure to Specialty Pigments and Additives in Coatings.

1. The student will learn about the metallic and pearl effect and changes in pigmentary properties in reference to nano size.
2. The Technocrat will have exposure to Mechanism, dosing and Trade information of coating additives and surfactants.

Course Contents:

Unit I:

Metallic, Interference and Cholesteric Pigments

Aluminum, copper, zinc dust, bronze, nickel stainless steel, lead powders and pastes, Nacreous, luminescent (fluorescent/phosphorescent) pigments-optical principles, substrate free pearlescent pigments, Special effect pigments based on mica (pigments formed by coating of substrates), pigments based on liquid crystal polymer

Unit II:

Functional and Nano Pigments

Antifouling pigments-cuprous oxide, other copper compounds, mercuric oxide, barium metaborate, organotin pigments, Manufacture and properties of nanopigments: alumina, silica, titanium dioxide, iron oxides, zinc oxides, silver, $CaCO_3$, etc. on Nano scale; variables affecting particle size aggregation and crystal structure. Their use as spacing extenders / functional pigments in paints, reinforcing agent in polymers, heat & wear resistant materials, etc.

Unit III:

Surfactants and Surface Additives

Anionic, cationic, non-ionic and amphoteric surfactants; polymeric surfactants, Gemini surfactants, HLB value, CMC, Kraft point. Role of surfactants as- emulsifier, wetting agents, dispersing agents. Surface additives, role of silicone and Fluro surfactants as surface additives flow and levelling control agents, slip additives

Unit IV:

Specialty additives in Solvent Borne CoatingsAntisettling agents, additives for rheology control, adhesion promoters, antiskinning agents, light stabilizers (UV absorbers, antioxidants, HALS), moisture scavengers, hammer and wrinkle finish additives, conductivity control additives etc.

Unit V:

Specialty additives for Water Borne Coating

Auxiliary and coalescing solvents, neutralization agents, thickeners, antifoam, antifreeze-thaw, Preservatives (In- can/film)-fungicides, mildew agents, corrosion inhibitors etc.

Text/Reference Books:

1. Jones, Frank N., Mark E. Nichols, and Socrates Peter Pappas. *Organic Coatings: Science and Technology*. John Wiley & Sons, 2017.
2. Swaraj, Paul. *Surface Coatings: Science and Technology*. J. Wiley & sons, 1985.
3. Karsa, D. R.; Davies, W. D., Eds., *Waterborne Coatings and Additives*, Royal Society of Chemistry,Cambridge, 1995.
4. Buxbaum, Gunter, ed. *Industrial inorganic pigments*. John Wiley & Sons, 2008.
5. Berte, J. N. "*High Performance Pigments*, ed Smith HM." (2002): 27-40.
6. Bieleman, Johan, ed. *Additives for coatings*. John Wiley & Sons, 2008.
7. Herbst, Willy, and Klaus Hunger. *Industrial organic pigments: production, properties, applications*. John Wiley & Sons, 2006.
8. Calbo, Leonard J. *Handbook of coatings additives*. 1987.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Optical effects and **evaluation** of Metallic, Interference and Cholesteric Pigments in coatings.	5
2	**Synthesis**, properties and applications of Functional and Nano pigments.	5
3	**Constructive**, corrective and **comparative** role of various additives in solvent borne, waterborne and other coatings.	5
4	Dosing and trade information of Additives in Coatings.	2

Course Title: Polymer Rheology (Open Elective-I)

Course Code: PLL-304 (Open Elective-I)

Theory: - 3 Hrs./week . **Total Credits: - 3.0**

Course objectives:

1. To understand the flow properties of polymers in terms of various models to study viscoelastic behavior of the polymers.
2. To know the thermo viscoelastic behavior of polymers during processing and selection of design of processing device.
3. To understand the processing of various types of polymers, selection of device for processing on the basis of flow properties

Course Contents:

Unit I:

Rheological Principles: Rheological Parameters, relationship between rheological parameters, Rheological systems: purely elastic, viscous, Types of fluids: Newtonian and Non Newtonian fluids, Viscoelastics fluids, Rheological or Constitutive equations.

Unit II:

Viscoelastic Nature of Polymers: Elasticity moduli and their time dependence, static and dynamic experiments to understand the time dependence , tan, its significance and method of determination, models of viscoelasticity, mechanical models such as Maxwell, voight, combinations of Maxwell and voight models to simulate viscoelastic behavior, salient features of molecular theories of viscoelasticity.

Unit III:

Glass Transition, Theories to determine the glass transition i.e.Dillatometric, Heat capacity, measurement, Thermomechanical, Measurement of modulus of elasticity, effect of Tg on molecular mass, kinetic chain flexbility and chemical constituent, Importance of Tg and Tm.

Unit IV:

Viscoelastic behavior of Polymer solution and melts stress-strain curves for Polymers, creep curves of Polymeric material, elastic deformation, irrecoverable follow deformation.

Rubber like deformation, Time-temp superposition (WLF Equation)

Unit V:

Methods to determine shear viscosity by capillary, parallel plate and cone and plate Rheometer, Measurement of normal stresses. Application of rheology to polymer processing.

Text/Reference Books:

1. P.N.Cogswell, Polymer Melt Rheology, A guide for Industrial Practice, George Godwin, Second Edition, 1981.
2. Richard C. Progelhof and James L. Throne, Polymer Engineering Principles, Hanser Publishers, New York, 1993.
3. John M. Dealyand Kurt F. Wissburn, Melt rheology and its role in plastics processing, Chapman, London, 1995.
4. R.S. Lenk, Polymer Rheology, Applied Science, London, 1978.
5. J.D. Ferry, Viscoelastic Properties of Polymers, john Wiley & Sons, New York, 1986.
6. Chang Dae Han. Rheology in Polymer Processing, Academic Press, New York, 1976.
7. R.J. Crawford, Plastics Engineering, Butterworth - Heinemann, Oxford, 1998
8. B.R. Gupta, Applied Rheology in Polymer Processing, Asian Books Pvt. Ltd. 1st Edition, 2005.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Flow behaviour of the polymers and various models used for **determination** of flow properties.	3
2	**Design**features of the processing device on the basis of processing parameter as temperature, pressure, shear rate.	6
3	Proper **selection**of processing equipment with respect to change in polymer, polymer flow properties.	4

Course Title: Nanoscience and Nanotechnology (Open Elective-I)

Course Code: CHL-320 (Open Elective-I)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

The objective of the course is to introduce students about emerging field of Nanoscience and Technology. Students will learn about properties of nanomaterials and their applications.

UNIT-I

Quantum chemistry, Solid state Physics, Nanomaterial & Manufacturing, Renewable energy generation, Nanotechnology in drug delivery, Nanotechnology in cosmetics, Bio-nanotechnology, Nanotechnology & information technology, Nanotechnology in agriculture and food industry, Environmental nanotechnology, Nanotechnology Health risk.

UNIT-II

Synthesis methods of nanostructures: Top-Down and Bottom-up approach of synthesis, Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Solvothermal synthesis.

UNIT-III

Nanostructures and its applications: Carbon Nanotubes (CNT), Graphenes, Fullerenes, Nano Peapods, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide, Silver, Copper Nanoparticles) Nanowires Polymer-based Nanostructures including dendrimers, nanofillers like clay, $CaCO_3$, $CaSO_4$.

UINT-IV

Nanocatalysis: Nanomaterials as catalysts for a variety of homogeneous and heterogeneous catalysis applications. Impact of the intrinsic properties of nanomaterials on catalysis, Various methods like Chemical Reduction Method, Thermal, Photochemical and Sonochemical Reduction Method, Applications of Nanocatalysis in Chemical Industry.

UNIT-V

Characterization techniques in analysing Nanomaterials: Scanning/transmission electron microscopy (SEM/ TEM), XRD, Atomic Force Microscopy, Particle size analyser (PSA) and their applications.

Text/Reference Books:

1. Nanochemistry: A Chemical Approach to Nanomaterials, Geoffrey A. Ozin, Andre C. Arsenault, Royal Society of Chemistry, Cambridge, UK, 2005.
2. Chemistry of nanomaterials: Synthesis, properties and applications C. N. R. Rao, Achim Muller, A. K Cheetham, Wiely-VCH, 2004.
3. Metal Nanoparticles: Synthesis Characterization & Applications, Daniel L. Fedlheim, Colby A. Foss, Marcel Dekker, 2002.
4. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong, Ying Wang, World Scientific, 2011.
5. Nanoparticles and Catalysis: Didier Astruc (Editor), Wiley-VCH Verlag GmbH & Co. KGaA, 2008

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Choose** appropriate synthesis technique to synthesize nanostructures of desired size, shape and surface properties.	3
2	**Correlate** properties of nanostructures with their size, shape and surface characteristics.	4
3	**Select** appropriate analytical tools for characterization of nano materials.	4
4	**Appraise** on application of nanomaterials as catalyst.	5

Course Title: Numerical Method in Chemical Engineering

Course Code: CHC-310

Theory: 02 Hours/ week (Teaching Hours: 02, Tutorial: 00) **Total Credits: 02**

Course Prerequisite: Material and energy balance computations, Fluid Mechanics

Course Objectives:

The objective of the course is to introduce students for formulating and solving mathematical equations of engineering problems using numerical methods and computer programming. Optimization of variables using numerical techniques.

Course Contents:

UNIT- I

Solution of Simultaneous Linear Equation: Gauss Elimination Method, Matrix Inversion Method, Gauss Jordan Method, Jacobi's Iteration Method, Gauss Seidal Method, Relaxation Method, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton Raphson, Regula falsi etc.

UNIT - II

Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, Ordinary Differential Equations: Taylor' series method, Runga-Kutta method, Piccard's method, Euler's method

UNIT -III

Size and parameter optimization of Chemical Engineering problems using various numerical techniques.

Reference Books:

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.
2. S.C. Chapra& R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
3. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.

4. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.
5. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Develop** and convert chemical engineering problem in terms of mathematical equation and solve those set of equations using various mathematical techniques.	6
2	**Learn** about optimization techniques for optimization of various parameters of unit operations andprocesses.	1

Numerical Method in Chemical Engineering Lab

Course Code: CHC-310 (PR)

Practical: 02 Hours/ week **Total Credits: 1.0**

Course Objective: The objective of the course is to solve problems in different areas of chemical engineering e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc. using tools like Polymath, excel, Matlab etc.

Course Contents:

Introduction to use of computer for numerical calculations

Solving following types of mathematical equation using tools like Polymath, Excel:

1. Solution of linear algebraic equation
2. Solution of a non-linear equations using bracketing and Newton-Raphson method
3. Numerical integration
4. Solution of system of ODEs /PDEs
5. Parameter optimization and validation through mathematical tools

Reference Books

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.
2. S.C. Chapra& R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
3. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
4. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.
5. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Solve** chemical engineering problems involving Linear and non-linear equations, Ordinary and partial differential equations using mathematical tools.	3

Course Title: Essence of Indian Traditional Knowledge

Course Code: NC – 303

Course Objectives:

1. The course aims at imparting basic principles of thought process, reasoning and inferencing. with emphasis on sustainability connecting society and nature.
2. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
3. To focus on Indian Knowledge System, Indian perspective of modern scientific worldview and basic principles of Yoga and holistic health care system.

Course Contents:

Unit-I

Introduction to traditional knowledge: Traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, western knowledge. Indian personalities in traditional knowledge, Linking Science and the Rural

Unit-II

Protection of traditional knowledge: The need for protecting traditional knowledge, Significance of TK Protection, Global Mechanisms of Protection and Sharing, recognition and protection value of TK in global economy, Role of Government to harness TK.

Unit-III

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.

Unit-IV

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

Unit-V

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Reference Books:

1. Sengupta, Nirmal, Nirmal Sengupta, and Ghosh. *Traditional Knowledge in Modern India*. Springer India, 2019.
2. Jha, Amit. *Traditional knowledge system in India*. Atlantic Publishers & Distributors, 2009.
3. Basanta Kumar Mohanta and Vipin Kumar Singh *Traditional Knowledge System and Technology in India*, Pratibha Prakashan 2012.
4. Kapoor, Kapil, and Michel Danino. "Textbook of" Knowledge Traditions and Practices of India"." *Ancient Science of Life* 32, no. 1 (2012): 59.

E-Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Ability to **understand**, connect and explain basics of Indian Traditional knowledge modern scientific perspective	2
2	Know the need and importance of protecting traditionalknowledge.	2
3	Know the various enactments related to the protection of traditionalknowledge.	2
4	**Understand** the concepts of Intellectual property to protect the traditionalknowledge.	2

Semester-VI (Third Year)

Course Code	**Course Title**	**Teaching Hours**	**Tutorial**	**Credits**	**Practical Hours**	**Credits**	**Total Credits**
CHC-311	Chemical Reaction Engineering – II	03	01	04	03	1.5	5.5
CHL-312	Process Design and Project Management	03	-	03	-	-	3.0
CHC-313	Mass Transfer–II	03	01	04	03	1.5	5.5
Elective II	Open Elective	03	-	03	-	-	3.0
Elective III	Professional Elective Courses	03	-	03	-	-	3.0
Total Credit							**20.0**

Course Title: Chemical Reaction Engineering - II

Course Code: CHC – 311

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Chemical Reaction Engineering - I

Course Objective:

1. This course provides basic understanding of catalysis along with kinetics and mechanistic aspects of catalysis.
2. The course will deal with problems involving Design and Rating of Catalytic Reactors and Gas-Liquid Reactors.

Course Contents:

Unit - I

Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterisation of catalysts. Physical and chemical adsorption, Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst.

Unit – II

Kinetics of solid catalyzed gas phase reaction, Laboratory reactors for catalytic gas solid reactions. Design concepts.

Unit – III

Mass transfer, Diffusion and Chemical reactions in catalysts. Effects of external mass transfer and heat transfer, Effectiveness factor (Thiele Modulus). Design aspects of catalytic reactors.

Unit – IV

Non-catalytic gas-solid reactions, different model for gas-solid reactions.

Unit – V

Gas liquid reactions, film and penetration theories, enhancement factor in gas-liquid reactions, gas-liquid reactors using emfrical indices.

Text/ Reference Books

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall 2001.
2. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.

3. Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** basics involved in catalysis for reaction mechanism	2
2	**Design** catalytic reactors	6
3	**Identify** regions of mass transfer control and reaction rate control and calculate conversion.	2

Chemical Reaction Engineering - II Lab

Course Code: CHC-311 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Objective:

1. This laboratory course provides basic understanding of catalysts along with kinetics and mechanistic aspects of catalysis.
2. The course will deal with problems involving analysis of non-ideal reactors and catalytic reactors.

Course Contents:

1. To study the RTD in CSTR - Pulse.
2. To study the RTD in CSTR - Step.
3. To study the RTD in PFR - Pulse.
4. To study the RTD in PFR - Step
5. To study the Rate of Catalytic Reaction.
6. To study Characterization of Catalysts.
7. To study Non-Catalytic (S/L) Reaction.
8. To Study Differential Reactor Analysis.
9. To study Carberry Type Reactor.
10. To study the Packed Bed Reactor.

Text/ Reference Books

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall 2001.
2. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.
3. Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** basics involved in catalysis for reaction mechanism	2
2	**Interpret** non-ideal behaviour of real reactors.	2

Course Title: Process Design and Project Management

Course Code: CHL-312

Theory: 03 Hours/ week (Teaching Hours: 03, Tutorial: 00) **Total Credits: 03**

Course Objectives

The objective of the course is to provide students with a firm grasp of the essential principles of Management, Project identification project feasibility and Project Scheduling Technique with Suitable Examples. Students will able to understand HAZOP design and read the PID of the plant. Students will able to understand economics for chemical processes.

Course Contents:

UNIT I

1. Project identification, project feasibility,
2. Project testing based on viability, risk & Cost estimation,
3. Evaluation of project by different methods on the basis of Visibility i) Net Present Value method. ii) Method of Rate of Return on Initial Investment iii) Pay out Period iv) Method of Discount Cash Flow v) Capitalized cost method vi) Internal rate of return method vii) Break Even Chart
4. Evaluation of project by different methods on the basis of Risk i) Profitability Index ii) Demand fore casting iii) Standard Deviation Approach
5. Evaluation of project by different methods on the basis of Cost i) Preparation of Cost sheet and statements ii) Preparation of Profit Loss Statement.

UNIT II

1) New developments in management, CPM & PERT, Principle and Objective of CPM and PERT Network Diagram for calculation Time Duration
2. Linear Programming Problem (Numerical based on each method) i) General simplex method ii) Primary & Dual technique method iii) Direct simplex method iv) Graphical Method.

UNIT III

1. Cost analysis, fixed capital, working capital, Preparation of store ledger account by pricing issue methods. LIFO, FIFO, Simple average, weighted average
2. Depreciation, significance of inadequacy and obsolescence, and depreciation methods.

UNIT IV

1. Layout and location, objective, principle
2. layout and Location factors.
3. Equipment layout diagram (ELD)

4. Tank firm cum utility block diagram for different processes.

UNIT V

HAZOP: Introduction and guide word, application of HAZOP to processes with examples.

PID: Basic symbols for various piping and instruments. Development of PFD, P&ID, PDS for different processes.

Text/ Reference Books

1. Process equipment Design by S.D. Dawande.Denett and Co Fifth Edition
2. Industrial Organization &Management B.V. Pathak & M.S. Mahajan, NiraliPrakashan First Edition 1986
3. Plant Design & Economics for Chemical Engineering by M.S. Peters &K.D.Timmerhaus. Fifth Edition
4. Shreves Chemical Process Industry George J, Fifth Edition 2017
5. Outlines of Chemical Process Technology by Drydens, Third Edition, 1997
6. Plant Utilities by D.B.DhoneNiraliPrakashan, First Edition 2008.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	To **evaluate** feasibility of project.	5
2	To **apply** various methods of profitability evaluation.	3
3	To **identify** the new development in project management and optimization techniques.	2
4	To carry out HAZOP **analysis** for safety of the process.	4

Course Title: Mass Transfer - II

Course Code: CHC – 313

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisites: Mass Transfer – I

Course Objective: Objective of this subject is to expose students to understand the basics of distillation, liquid-liquid extraction, adsorption, leaching and crystallisation and its application to chemical engineering

Course Content:

Unit- I

Distillation of binary mixtures: Vapour – liquid equilibria, governing law's, X-Y, T-X-Y and P-X-Y, H-X-Y diagrams, relative volatility, minimum and maximum boiling azeotropes, Types of distillation, Rayleigh Equation and Rayleigh Equation in terms of relative volatility, azeotropic and extractive distillation.

Unit- II

Lewis-Sorel, McCabe Thiele methods: Multiple feed, side stream, estimation of number of stages required in distillation column. Operating and feed lines, feed conditions, Importance of ratio reflux, minimum and optimum reflux ratio, Underwood-Fenske equation for minimum reflux ratio and Fenske's method for number of plates at total reflux. Tray and column efficiency. Batch distillation- continuous binary fractionation, Packed column distillation: rate-based methods: HETP, HTU, PonchonSavarit method.

Unit- III

Liquid-Liquid Extraction: fundamentals, solvent selection, triangular diagram representation, Single stage extraction and multistage cross current and counter current extraction Equipment for liquid-liquid extraction. (Mixer settler, Rotating Disc Contractor, Packed column, spray column) equipment selection criteria.

Solid– Liquid Extraction fundamentals, Solvent selection, equilibrium relationship, rectangular diagram representation, calculation of number of stages. Equipment's for solid – liquid extraction, design selection criteria.

Unit- IV

Adsorption and Ion exchange: Types of adsorption, adsorbent, Breakthrough Curves, isotherms, Ion-

Exchange Equilibria, Equilibria in Chromatography.

Crystallization: Theory of solubility and saturation, phase diagram (temp/solubility relationship), Supersaturation, Nucleation, Crystal Growth, Population balance analysis, method of moments for rate expressions. evaporative and cooling (rate expressions), Process design of crystallizers and their operation, Crystallisation equipment's.

Unit- V

Special topics in separation: Mechanism of solute/solvent rejection in the process, Types of membrane separation processes, reverse osmosis, ultrafiltration, gas separation, vapour permeation and pervaporation, dialysis, electrodialysis, nanofiltration.

Transport Through Porous Membranes, Resistance Models, Liquid Diffusion through Pores, Gas Diffusion through Porous Membranes, Transport Through Nonporous Membranes.

Text/Reference books:

1. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977
2. J. D. Seader and E. J. Henley, Separation Process Principles, Second Edition, Wiley Asia Student Edition.
3. A. L. Hines, R. N. Medox, Mass Transfer: Fundamental and Application.
4. Binay K. Dutta, "Principles of Mass Transfer and Separation Processes", 2nd edition, Prentice Hall of India,2007
5. R. E. Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill, New Delhi, 1983.
6. A.S. Foust, "Principles of Unit Operations", 2nd Edition, Wiley, New York, 1980.
7. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, Tata McGraw Hill, India, 2014.
8. C.J. Geankoplis, "Transport Processes and Unit Operations", 3rd Edition, Prentice Hall, India, 1993.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Analyze** liquid–liquid extraction and solve problems on single and multistage extraction.	4
2	**Interpret** the fundamentals of distillation and **Estimate** the number of	2

	stages for distillation column.	
3	**Evaluate** adsorption, ion exchange and crystallization technology.	5
4	**Understand** novel separation techniques	2

Mass Transfer – II Lab

Course Code: CHC-313 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Objectives:

To provide the hand-in-hand experience of lab-scale experiments on various types of equipment based on the theoretical understanding and its application learned in theory course.

Course Contents:

1. Study Vapour -liquid equilibria (T-X-Y) for given system
2. Verify Rayleigh equation (Differential distillation)
3. Study Steam Distillation
4. Study of operating parameters of fractionating column. (ethanol-water syster)
5. Construct binodal curve for Acetic acid- water-benzene system.
6. Determination of distribution coefficient of Single stage liquid -liquid extraction for Acetic acid-water-benzene system.
7. Single stage solid-liquid extraction for sand -oxalic acid system
8. Study Batch adsorption for acetic acid-water-activated carbon/charcoal
9. Determination of yield crystallisation.
10. Study ion exchange equilibria

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Develop** the ability regarding analytical and data interpretation skills.	6
2	**Understand** the scaling approach of understanding from Experimental to Industry applications.	2
3	**Plan** an appropriate approach to experiment work and **justify** plans in the light of preliminary findings.	4
4	**Demonstrate** safe working in the choice of method and apparatus.	2

Text/Reference books:

1. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977

2. J. D. Seader and E. J. Henley, Separation Process Principles, Second Edition, Wiley Asia Student Edition.
3. A. L. Hines, R. N. Medox, Mass Transfer: Fundamental and Application.
4. Binay K. Dutta, “Principles of Mass Transfer and Separation Processes”, 2nd edition, Prentice Hall of India,2007
5. R. E. Treybal, “Mass Transfer Operations”, 3rd Edition, McGraw Hill, New Delhi, 1983.
6. A.S. Foust, “Principles of Unit Operations”, 2nd Edition, Wiley, New York, 1980.
7. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, Tata McGraw Hill, India, 2014.
8. C.J. Geankoplis, “Transport Processes and Unit Operations”, 3rd Edition, Prentice Hall, India, 1993.

Course Title: Treatment and Disposal of Food Industrial Waste

(Open Elective-II)

Course Code: FTL-306 (Open Elective-II)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course Objectives:

1. To study composition, sources, permissible and health hazards of industrial wastewater pollutants
2. To study various techniques of wastewater treatment by physical chemical and biological methods
3. To study, design and operational problems of biological treatment and value addition to waste
4. Estimation of kinetic coefficients for treatment with design problem.

Course Contents:

Unit I:

Physical, chemical and biological characteristics of food industry waste. Composition of typical industry waste. BOD /COD and characterization of effluent. Typical BOD of some food industrial effluents and their discharge limit, types and point sources of industrial pollutants and adverse effect by their discharge.

Unit II:

Primary treatment, secondary and tertiary treatments by physical, chemical and biological methods. Process design criteria. Sanitary disposal of sludge.

Unit III:

Role of micro-organisms in food industry waste. Application of kinetics to biological treatment. Determination of kinetic coefficients with some design problems.

Unit IV:

Activated sludge process and modified activated sludge process. Nitrification and denitrification, Aerobic lagoons, aerated aerobic lagoons, aerated facultative lagoons, Design criteria for A.S.P and stabilization ponds

Unit V:

Trickling filters, Rotating biological contactors, design criteria and problem on RBC and trickling filter

design. By product recovery and value addition to the waste.

Text/Reference Books:

1. Environmental Pollution Control Engineering – C.S. Rao
2. Wastewater treatment and pollution control -Soli Arceivala and Shyam R Asolekar
3. Food Processing Waste Management – J.H.Green and A. Kramer
4. Wastewater treatment; Bartlett RE; Applied science publication Ltd
5. Wastewater Engineering: Treatment, Disposal and Reuse by Metcalf & Eddy (Second Edition)
6. Handbook of Waste management and co-product recovery in Food Processing – Vol.1- Keith Waldron
7. Food industry waste: Disposal and recovery; Herkza A & Booth RG;1981; Applied science publication Ltd.
8. Environmental Biotechnology; Bhattacharyya B C & Banerjee R; Oxford University press.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Student will be able to **explore** composition of industrial effluent and health hazards of pollutants in effluent	2
2	Student will be able to **recognize** Primary, secondary and tertiary treatment for industrial effluent treatment and design parameters	1
3	The students will be able to access principle, **design** and working of fixed film biological reactor efficiency	6
4	The student will able to **manipulate** industrial effluent for recovery of biological as value addition to waste.	3

Course Title: Biochemistry & Biotechnology of Lipids (Open Elective-II)

Course Code: OTL-306 (Open Elective-II)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

This course is designed to gain the insights about various bio-simulated reactions, pathways, and mechanisms in natural way. Also, the use of enzymes for synthetic modification and applications several fatty products will be studied. Environmental issues from bio-technological industries will also be discussed.

Course Contents:

Unit I:

Biosynthesis of fatty acids and phospholipids; Mechanism of chain elongation and desaturation of acyl chains; Regulation of lipid metabolism; Biological role of fat in human nutrition; Atherosclerosis.

Unit II:

EFA, MUFA, PUFA –Sources and biological activities in human health; Biochemical aspects of vitamins in nutrition; Toxic constituents in oilseeds and oils: Sources, structures, toxicological effects and methods of detoxification.

Unit III:

Microbial production of fats and other lipids; Biotransformation of fats and lipids using whole microbial cells; General aspects of Microbial Lipases: Sources, isolation and purification and industrial applications.

Unit IV:

Enzymatic Interesterification: Chemistry, reaction in (aqueous/organic) solvent systems, immobilization of enzymes, factors affecting enzyme activity, enzyme kinetics, reactor design.

Unit V:

Structured lipids: Synthesis, analysis and applications

Genetically modified lipids: Physical, chemical and nutritional functionality modifications.

Environmental biotechnology concept: Principles in bioremediation and biological water & waste treatment.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Acquire** the fundamental knowledge of scholarly discourse in lipid synthesis, **recognize** the biological roles vitamins and **examine** the toxicology of lipid components.	1
2	**Combine** the theories and concepts of microbial lipase in industrial applications.	6
3	**Illustrate** the critical skills in solving the reaction kinetics and optimizing the enzymatic process.	4
4	**Differentiate** between structured and genetically modified lipids and **identify** ethical issues in environmental bioremediation.	2

Text/Reference Books:

1. Lehninger's Principles of Biochemistry by David L Nelson; A.L.Lehninger and Michael M. Cox, 5th edition, Worth Publishing.
2. Outline of Biochemistry by Eric.E. Conn and P.K. Stumpf, 5thedition, Wiley India.
3. Lipids: Biochemistry, Biotechnology and Health, 6th Edition by Michael I. Gurr, John L. Harwood, Keith N. Frayn, Denis J. Murphy, Robert H. Michell, Wiley-Blackwell
4. Fatty Acids in Fish OğuzTaşbozan and Mahmut Ali Gökçehttp://dx.doi.org/10.5772/68048
5. Food Lipids Chemistry, Nutrition, and Biotechnology, Fourth Edition Edited Casimir C. Akoh Taylor & Francis Group

Course Title: Technology of Printing Inks (Open Elective-II)

Course Code: PTL-306 (Open Elective-II)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

The Paint Technocrat will have in depth exposure to

1. Formulation and manufacture of Printing Inks.
2. Various techniques of printing processes.
3. Different applications of printing inks

Course Contents:

Unit I:

Nature of Printing ink, Visual characteristics of inks, Major printing systems, classification and characteristics of printing inks, mechanism of ink drying, adhesive nature of printing inks, resistance properties of printing inks, physical chemistry of printing inks, rheological properties of inks principles of printing

Unit II:

Description and schematic diagram of printing processes, press configuration and applications e.g. Flexographic, lithographic, gravure, letterpress, planographic, screen, Inkjet printing, substrate selection principles of ink formulations, colour matching and process printing.

Unit III:

Manufacture of inks, manufacturing process, mixing equipment such as High-speed impeller, butterfly mixer, Rotor and stator high speed mixer and milling equipments such as three roll mill, bead mill etc. handling, storage and manufacture of UV ink, newspaper inks, modern production trends and future of inks.

Unit IV:

Inks for various substrates: paper, plastic, fabric, leather, glass and metal. Testing & Evaluation of finished ink and raw materials for ink manufacture. Inks for Newspaper (rotary and well offset), publication work, posters, labels, and packaging materials, heat set and quick set inks for multicolor printing.

Unit V:

Metal decorating inks, after print varnishes and lacquers, magnetic inks, ceramic inks, inks for printed circuit boards, inkjet printing, laser printing, dot-matrix printing, and other miscellaneous inks. Identification of various ink troubles and remedial measures

Course Outcomes:

Upon successful completion of the course, the students will learn about

CO No.	Course Outcome	Cognitive level
1	Nature, characteristics and classification of printing inks.	4
2	Principles of ink **formulations** and manufacture of Inks for various substrates	6
3	Press configuration and **applications** of printing inks	3
4	**Comparison** and selection of various printing processes	4

Text/Reference Books:

1. Jones, Frank N., Mark E. Nichols, and Socrates Peter Pappas. *Organic Coatings: Science and Technology*. John Wiley & Sons, 2017.
2. Leach, Robert. *The printing ink manual*. Springer Science & Business Media, 2012.
3. Thompson, Robert. *Printing materials: science and technology*. Pira International, 2004.
4. Flick, Ernest W. *Printing ink and overprint varnish formulations*. William Andrew, 1999.

Course Title: Plastics Waste Management (Open Elective-II)

Course Code: PLL-305 (Open Elective-II)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

1. To understand the concept of plastics recycling.
2. To understand about various sources of plastics waste.
3. To understand various identification and separation method for waste plastics.
4. To learn about different recycling methods for plastics recycling.

Course Contents:

Unit I:

Introduction, Sources of plastics waste (Industrial waste, post consumer waste, scrap waste and nuisance waste), Plastic identification and Separation techniques – (density - float sink and froth floatation methods, optical, spectroscopic, electrostatic, sorting by melting temperature, sorting by size reduction, sorting by selective dissolution and other methods), recycling codes.

Unit II:

Plastics Waste Management - 4R‟s approach (reduce, reuse, recycle – mechanical and chemical, recover),recycling classification- - primary - secondary - tertiary - quaternary recycling with examples. Energy from waste – incinerators-pyrolysis, factors affecting incineration.

Unit III:

Recycling of polyolefins - PVC, PET, polystyrene, polyamides-nylon-6 and nylon-6,6, polyurethanes, mechanical process, applications of recycled materials.

Unit IV:

Recycling of rubber – comparison of thermoset and thermoplastic composites, reclaiming of rubber – fuel source – pyrolysis, Depolymerisation of scrap rubber, tyre retreading, uses of recycled rubber – asphalt and other uses.

Unit V:

Recycling of plastics by surface refurbishing - coating application, influence on plastics properties by coating, polishing of the plastics surface, commercial process. Plastics aging - environmental aging, thermal aging, weathering of plastics, mechanical degradation, chemical degradation and environmental

stress cracking, wear and erosion, influence of plastic aging in recycling, energy from waste – incinerators.

Course Outcomes:

Upon successful completion of the course, students will have knowledge of

CO No.	Course Outcome	Cognitive level
1	Sources of plastics waste, its identification and separation methods.	2
2	Approaches of plastic waste management	2
3	Mechanical and chemical recycling of polymers.	2
4	Recycling of plastics by surface refurbishing.	2

Text/Reference Books:

1. John Scheirs., - "Polymer Recycling Science, Technology and applications" John Wiley and Sons, 1998
2. Nabil Mustafa – "Plastics Waste Management Disposal Recycling and Reuse" Marcel Dekker Inc., First Edition 1993.
3. Steven Blow, Handbook of Rubber Technology, Galgotia Publications Pvt. Ltd., New Delhi, 1998.
4. Chandra R. and Adab A., Rubber and Plastic Waste, CBS Publishers & Distributors, New Delhi, 1994.
5. Muna Bitter, Johannes Brandup, Georg Menges "Recycling and Recovery of plastics" 1996
6. Attilio.L.Bisio, Marino Xanthos, "How to manage plastics waste: Technology and market Opportunities" Hanser Publishers, 1994
7. Francesco La Mantia., "Handbook of Plastics Recycling" Chem Tec Publishing,2002

Course Title: Water Conservation and Management (Open Elective-II)

Course Code: CHL-321 (Open Elective-II)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

The Objective of this course is to

1. Understand current water scenarios
2. Need for water conservation and management
3. Strategies for water conservation from source to sink in different sector.

Course Contents:

Unit I:

Introduction: water cycle, water storage, water quality. Water conservation, Current Demand of water for Domestic, Irrigation and Industries.

Current supply available, Shortage of water, water conservation process and ways to conserve water.

Unit II:

Understanding water conservation and water quality parameter like TDS, pH, etc. Water management-water quality, controlling use and quality of water, water flow management, water quality control, testing water salinity, preserving water quality. Managing water quality in different sectors.

Unit III:

Water conservation in agriculture-Reuse of wastewater for irrigation (Methods, Precautions), Irrigation system (Components) and Water user's participation in irrigation system management. Current Supply, utilization and shortage of water

Unit IV:

Water conservation in construction industry: Importance of saving water in the construction industry in India, reduce and recycle water at construction sites, saving water during wall construction.

Unit V:

Water Conservation in process industry: Water treatment, recycling, and reuse Water saving equipment, economics of water, minimising evaporation, water audits.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students would able to **understand** the importance of water conservation and management in different sectors.	2
2	Studentswouldableto**identify**thethrustareaforwaterconservationanddevelopmanagement strategies to achieve it.	2
3	Students would able to effectively **implement** the developed strategies.	2

Text/Reference Books:

1. Irrigation Engineering-R.K. Sharma and T.K. Sharma, S.Chand& Company Ltd., New Delhi.
2. Water Resources Systems: Modeling Techniques and Analysis Vedula, S.and Mujumdar, (2005); Tata McGraw Hill, New Delhi.
3. Economics of Water Resources Planning, James, L.D., and Lee, R. R., Mc Graw Hill.
4. Agriculture and water management, P.Verma, Amiga Press Inc.
5. Industrial water treatment process technology, Parimal Pal, Elsevier Science.

Course Title: Environmental Pollution and Control (Professional Elective-III)

Course Code: CHL-322 (Professional Elective-III)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

1. To provide detailed knowledge on the discharge of pollutants, either of natural or of anthropogenic origin, into the environment that can induce severe stresses on ecosystems and their inhabitants.
2. To train students to act as experts in the area of reducing and remediating the impact of wastewater and air pollution.
3. To introduce theoretical and practical principles of natural purification processes and technological processes to control discharges which drive purification and remediation technologies, with reference to the legislative framework concerned with safeguarding the environment and human health.
4. To impart knowledge to enable students to critically review modern technology and practices for the monitoring, prevention, treatment and disposal of wastewater and air pollutants.

Course Contents:

Unit I:

Sources and pathological effects of CO_2, SO_2, NO_2, H2S and volatile organic emissions; Classification of particulate matter on the basis of particle size ; standards for clean air; Mechanism and remedial measures of photochemical Smog, Green House Effect and Ozone layer depletion.

Unit II:

Factors affecting stability of Dispersion & temperature inversion; Methods for control of particulate matter Design, construction and operation of Gravity Settler, Cyclone separators, Electrostatic precipitators, Fabric Filters, Venturi scrubbers, Spray and Packed bed tower. Problems on Design, Comparative performance evaluation. Removal of gaseous pollutants by absorption by liquids and adsorption by solids, control of volatile organic emission.

Unit III:

Primary and secondary wastewater Treatment Techniques:

Physical characterization of wastewater (Colour, odour, turbidity, MLSS, Dissolved solids etc.); Principle and significance of determination of BOD, COD, DO, TOC; Use of electrochemical analyzer

and atomic absorption spectrometer in determination of elements; estimation of phosphorous and nitrogen.Primary Treatment Techniques (Neutralization, equalization, segregation, flocculation, micros trainers etc.) & Secondary Treatment techniques (Aerobic & Anaerobic using different filters/contactors).

Unit IV:

Tertiary/ Advanced Wastewater Treatment Techniques and Solid Waste Pollution:

Methods of sampling and analysis of SO_2, NO_2, & CO_2, ; Principle and utilization of Adsorption, Ion Exchange, Electrodialysis, reverse osmosis, ultra-filtration in wastewater treatment. Overall layout of Municipal (Domestic) and Industrial Effluent Treatment Plant Techniques for handling, disposal and control of solid waste pollutants (Composting, dumping, incineration, physical and chemical recycling).

Unit V:

Pollution control strategies in selected Food, Pharmaceutical & Chemical Industries: Beverages, Distillery, Sugar, Canning, Dairy; Antibiotics (Penicillin, Cephalosporin; etc.), Sulpha Drugs, Petroleum Refinery and Petrochemical Industries.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Identify** sources, types and quantities of pollutants and determine their impact on the environment	2
2	**Identify** and propose strategies and techniques for the management and control of pollution.	2
3	**Design** equipment's for control of pollutants in various sectors.	6

Text/Reference Books:

1. "Pollution Control in Process Industries" by S.P. Mahajan MC Graw Hill
2. "Environmental Pollution Control Engineering" by C. S. Rao.
3. "Wastewater Treatment" M. Narayanrao& A.K. Dutta, IBH Publicaiton Co Pvt. Ltd., Delhi.
4. "Wastewater Engineering" Mc Catta , Mc Gvaw Hill.
5. "Air Pollution Control", P. Pratap Mouli and N. Venkata, Diva Jyoti Prakashan, Jodhpur.
6. Physico- Chemical Process for water quality control, W.J. Weber, Wiley Interscience- 1972.

Course Title: Petroleum Refining Engineering (Professional Elective-III)

Course Code: CHL-323 (Professional Elective-III)

Theory: - 3 Hrs./week. **Total Credits: - 3.0**

Course objectives:

1. To study about crudes, different petroleum products.
2. To study the basic petroleum properties, testing method, use and applications.
3. To study various distillation techniques, operations catalytic and thermal process.

Course Contents:

Unit I:

Occurrence, Origin and formation, Composition. Hydrocarbon group wise compositions of Petroleum & their structures, sulfur, nitrogen, oxygen & metal-organic compound in petroleum. Paraffins, olefins, acetylenes, naphthenes, aromatics and their general properties

Unit II:

Evaluation of petroleum, Characterization & properties of Crude oil, Gasoline and specifications, test for gasoline like ASTM Distillation, octane number, Reid vapor pressure.

Unit III:

Specifications of kerosene, Properties of kerosene flash and fire point, smoke point, aniline point, specifications of High Speed Diesel, properties like cetane number, diesel index, pour point, fire point, flesh point.

Unit IV:

Major petroleum products like Liquified Petroleum Gas , , Aviation turbine fuel, ,LDO, furnace fuels, lubricants, base oil, tar &biumen, asphalts, resin. Crude Distillation, Atmospheric Topping unit, arrangements of towers, top tray reflux, pump back reflux, pump around reflux and design aspects.

Unit V:

Vacuum distillation Unit, vacuum tower operating parameters. Catalytic Cracking and thermal cracking processes, Fluidised bed Catalytic Cracking, Catalytic Reforming process. Techno-economic aspects of

optimum refining scheme.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** basic concepts of Petroleum Refining Engineering.	2
2	**Know** different petroleum products, their properties and uses.	2
3	**Understand** about major operations carried out in Petroleum industries.	2
4	This course provides the knowledge of various petroleum processes	2

Text/Reference Books:

1. J.H Gary, &G.E .Handwerk, Petroleum Refining: Technology& Economic 3rdedition, Marcel Dekker Inc.1994
2. Modern petroleum refining processes B.K.Bhaskararao Oxford & IBH Publ.co.pvt.lt.
3. Equipment Design handbook for Refineries & chemical plants by Frank l. Evans, Gulf Publishing Company
4. Petroleum Refinery Engineering by W. L. Nelson, Mc Graw Hills
5. Petroleum Processing, Principles & Applications by R. J. Hengatabis, Mc Graw Hills

Syllabus of Final Year
B. Tech. (Chemical Engineering)

(Revised Syllabus w. e. f. 2021-22)

Faculty of Science and Technology

University Institute of Chemical Technology

Kavayitri Bahinabai Chaudhari

North Maharashtra University,

Jalgaon

(Academic Year 2021 – 22)

B. Tech. (Chemical Engineering) 4th Year

Revised Syllabus w. e. f. 2021-22

Seventh Semester B. Tech. (Chemical Engineering)

Course Code	Title of Course	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-414	Modelling, Simulation and CAD	03	01	04	03	1.5	05.5
CHL-415	Instrumentation & Instrumental Analysis	03	-	03	-	-	03.0
CHC-416	Process Dynamics & Control	03	-	03	03	1.5	04.5
CHC-417	Process Equipment Design & Drawing	01	-	01	02	01	02.0
Elective-IV	Professional Elective Course	03	-	03	-	-	03.0
						Total	**18.0**

Eighth Semester B. Tech. (Chemical Engineering)

Course Code	Title of Course	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHP-418	Industrial Training/ Project	-	-	-	24	12	12
CHP-419	Technical Seminar	-	-	-	06	03	03
						Total	**15**

List of Elective-IV (Professional Core Elective)

1. CHL-424 Newer Separation Techniques
2. CHL-425 Fundamentals of Computational Fluid Dynamics
3. CHL-426 Advanced Pharmaceutics

Course Title: Modeling Simulation and CAD

Course Code: CHC-414

Theory: 03 Hours/ week (Teaching hours: 03; Tutorial: 01) **Total Credits:** 04

Course Prerequisite: Mathematics, Mass Transfer, Heat Transfer, Fluid Mechanics, Fundamentals of core Chemical Engineering Courses.

Course Objectives:

1. The course covers detailed about concept of model building and model development.
2. The course aims application of laws of Physics and Chemistry into various flow systems for development of mathematical model.
3. The course helps in optimization of unit operations and processes with the development of Computer Aided Design.

Course Contents:

Unit-I

Introduction to process modeling and simulation, Roll of process Dynamics and control, Terminologies used in dynamics and control, Type of variables in control system, Applications/Uses of mathematical modeling in Chemical Engineering, fundament laws, servo and regulatory system, open and closed loop system, Feedback, Feed-forward control, Model Building concept, steps and in model building and block diagram, Classification of Models.

Unit-II

Principle of formulation of mathematical model, continuity equations, energy equations, equation of motion, Transport equations, equation of state phase and chemical equilibrium and kinetics. Development of mathematical models for (based on continuity equations, energy equations, equation of motion) Stirred Tank, Tubular Tank, CSTR, PFR, CSTR with Heat Removal, Jacketed Tubular Reactor, Gravity Flow Tank, Variable Mass System, Flow Through Circular Pipe.

Unit-III

Mathematical models of chemical engineering systems such as- CSTR'S/ Non-

isothermal CSTR with all variations, Two Heated Tanks, Vaporizers, Multi-component Flash Drum, Cone shaped Tank, Batch Reactor, Reactor with Mass Transfer, pH System in Waste Water Treatment.

Unit-IV

Mathematical models for complex system like Bioreactor, Steady state Extraction, Ideal Binary Distillation Column, Multi-component non-ideal distillation column, Batch Distillation with hold up, Introduction to Modeling simulation tools like DWSIM - Open Source Chemical Process Simulator/ Polymath, and few case studies.

Unit-V

Computer Aided Design:-Heat Exchanger, Separators (Vertical and Horizontal), Cyclone separator, Distillation columns.

Course Outcomes:

Upon successful completion of the theory course, students will be able to

1. Transfer and relate the basic concepts learnt in Chemical Engineering for representing system in the form of mathematical equations.
2. Develop and formulate mathematical model based on law of conservation ofmass, momentum and energy.
3. Solve**, simulate**and validate set of mathematical equations ie, mathematical model for various systems.
4. Plan and propose algorithm in order to perform computer aided design of various unit operations and processes.

Course Outcomes:

Upon successful completion of the theory course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Transfer and relate the basic concepts learnt in ChemicalEngineering for representing system in the form of mathematical equations.	2
2	**Develop** and **formulate** mathematical model based on law	6

	of conservation of mass, momentum and energy.	
3	**Solve, simulate** and validate set of mathematical equations I.e, mathematical model for various systems.	6
4	**Plan** and **propose** algorithm in order to perform computer aided design of various unit operations and processes.	6

R**eference Books:**

1. Luyben W. L.,"ProcessModeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill, 1990.
2. Najim K., "Process Modeling and Control in Chemical Engineering", CRC, 1990.
3. Aris R., "Mathematical Modeling,Vol. 1:A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999.
4. Computer Aided Design by Koker, 1980.

Course Title: Modeling Simulation and CAD (PR)

Course Code: CHC-414

Practical: 03 Hours/ week **Total Credits:** 1.5

Course Prerequisite: C programming, Chemical Engineering Mathematics

Course Objectives:

The course includes application of C programming language/ Polymath software/ MS Excel for solving model equations.

The course introduces about software like DWSIM - Open Source Chemical Process Simulator/ Polymath for simulation.

Course Contents:

Modeling and sensitivity study of chemical engineering systems such as CSTR in series, Cone Shaped Tank, Two Heated Tank, Gravity Flow Tank, Batch reactor (Complex Reaction Scheme) , PFR, distillation column etc. with the help of C programming/POLYMATH SOFTWARE.

Sample case studies and estimation of feed stream parameters using DWSIM - Open Source Chemical Process Simulator, Development of algorithm and computer aided design for heat exchangers, Gas- Liquid separators etc.

Course Outcome:

Upon successful completion of the practical course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Solve** set of mathematical equations using various software tools like polymath, C programming, Excel etc.	6
2	**Validate** and **optimize** mathematical model for various systems.	6
3	Independently **plan** and **develop** algorithm in order to perform computer aided design of various unit operations and processes.	6
4	**Choose** and **justify** best possible design configuration for	6

	given constraints.	

Reference Books:

1. Luyben W. L.,"Process Modeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill, 1990.
2. Najim K., "Process Modeling and Control in Chemical Engineering", CRC, 1990.
3. Aris R., "Mathematical Modeling, Vol. 1:A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999.
4. Computer Aided Design by Koker, 1980.

Software:

1. **Polymath 5.1 software**
2. WSIM - Open Source Chemical Process Simulator
3. MS- Excel-2007
4. C programming

Course Title: Instrumentation & Instrumental Analysis

Course Code: CHL-415

Theory: 03 Hours/ week **Total Credits:** 03

Course Objectives:

To impart the thorough knowledge about analysis, measurements of various parameters in chemical engineering and how to use them on the field in professional life.

To make the student to be able to understand and solve the problems in measurement and controlled systems by using standard methods.

Course Contents:

Unit-I

Elements of measuring system and their functions; Static and dynamic characteristics of measuring instruments; Dynamic characteristics of 1st order and 2nd order type measuring instruments.

Unit-II

Principles, construction, and operations of instruments for the measurement of Temperature: Expansion thermometers, Thermocouples, Thermistors, R.T.D, Radiation based temperature- measuring instruments.

Unit-III

Principles, construction, and operations of instruments for the measurement of Pressure: Pressure measurement using Manometers, elastic elements; Electrical Pressure Transducers; Pressure Multiplexers; Strain measuring instruments; Differential pressure measurement; Vacuum measurement.

Unit-IV

Level Measuring Instruments: Direct and indirect methods; Flow Measuring Instruments: Orifice meter, Venturi meter, Pitot tube, Flow nozzle, Rotameter, Piston type or valve type area meter, Reciprocating piston type flow meter, Turbine flow meter.

Unit-V

Measurement of Chemical Composition: Spectroscopic analysis: Absorption spectroscopy, Emission spectroscopy, mass spectroscopy, x-ray diffraction, colour, measurement by spectrometers.

Thermal Conductivity Analysis; Combustibility; Oxygen Analyzers; Chromatographic Methods; Electrochemical Methods.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	To get the students well acquainted with **basic** principles of operation, static and dynamic characteristics of various pressure and temperature measuring instruments.	2
2	To enhance the **knowledge** of students about various spectroscopic and chromatographic techniques for analysis.	3
3	The get the students well acquainted with basic knowledge of various sensors, controllers and their **application** in the control systems, advance control systems.	3

Reference Books:

1. Eckman & Donald P. “Industrial instrumentation”
2. Rangan C. S. &Sarma G.R. “Instrumentation devices & Systems”
3. Patranbis d. “Principle of Industrial instrumentation”
4. Vyas R.P. “Process control and instrumentation”
5. Donald R. Couighanowr& Koppel “Process Systems Analysis and control”
6. Harmon Ray “Process Dyanamicsmodeling and control”
7. Johnson, C.D., “Process Control Instrumentation Technology”, Pearson Education, Inc.
8. Liptak B.G. “Instrumentation in Process Industries”

Course Title: Process Dynamics and Control

Course Code: CHC- 416

Total Hrs/Week: 03 **Course Credit:** 03

Course Objective:

To study the chemical process control and dynamics of automatic, advanced chemical processes and to study the response of various forcing functions for first, second order control system by studying the various types of control mechanisms for chemical process and to examine stability analysis and application.

Course Contents:

Unit-I

Dynamic Behaviour of First Order Control System. Study of forcing functions Step, ramp, impulse, sinusoidal etc. Transfer functions of Continuous Stirred Tank Reactor, mercury in glass thermometer, mixing process, liquid level single tank system and problems with practical approach, response of first order control systems, step response, ramp or linear response, impulse response, sinusoidal response equations and problems.

Unit-II

Interacting and Non-Interacting liquid level Control Systems. Step response for non-interacting, interacting control system, Transportation lag, the dynamic behaviour of second order control systems. Transfer function derivation for U tube Manometer and Damped vibrator system, Concept of underdamped, critically damped and overdamped systems, Step response equation for under damped second order system. Problems on under damped second order control system.

Unit-III

Second order step response equations of critically and over damped control systems and derivations. Step response Characteristics of an Underdamped second order control systems for step function. Decay ratio, overshoot, rise time, response time and numerical. Mechanism of Control System and Block Diagram Representation Control aspects, negative verses positive feedback control systems, servo and regulator control problems.

Unit-IV

Proportional, proportional plus derivative, proportional plus integral and Proportional plus Derivative plus Integral controller their input output relationship, transfer functions of different controllers, advantages and disadvantages and their applications. Stability Analysis of Control System. Stability for linear control system, Rouths stability criteria and problems based on stability of control system.

Unit-V

Root locus analysis, procedure for plotting root locus diagram for negative feedback control systems. Various numerical and graphical problems based on Root locus analysis. Frequency response analysis of linear systems, procedure for plotting the Bodediagram, problems on Bode stability criteria, basics of open loop poles and zeroes at origins, first order poles and zeroes, corner frequency, concept of phase and gain margins, phase crossover and gain crossover frequencies.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	From the course contents, the students will be able to know the complete dynamics of the chemical process and **understand** the different kinds of forcing function and responses.	2
2	The students **understand** the method for obtaining the transfer function, response equation and physical behaviour of first, second and higher order control system.	2
3	Students understand various types of control actions like ON OFF, P, PI, PD, PID and **applications** and usefulness in the different chemical process and Industries.	3
4	Students able to know stability of chemical process control system by **solving** the problems of graphical methods and analysis of root locus frequency response analysis.	3

Reference Book:

1. Coughanowr, Donald R., Process Systems Analysis and Control, McGraw Hill. Third Edition,2009.
2. Stephanopoulos George, Chemical Process Control Prentice Hall Inc. First Edition.
3. Harriott Peter, Chemical Process Control, Tata McGraw Hill.T.M.H.Edition
4. Process Dynamic and Control,S.S.Bhagade and G,D,Nageswar First Edition 2011

Course Title: Process Dynamics and Control Lab.

Course Code: CHC- 416

Total Hrs/Week: 03 **Course Credit:**1.5

Course Objective:

To carry out an experiment of Process Dynamics and Control, the students come to know how the equations developed from physical system, their response studies and actual application to chemical process Industries during automatic process control.

1. Study of dynamic behaviour and response of Mercury thermometer for step change during heating.
2. Determination of time constant of mercury in glass thermometer, thermocouple, or bimetallic thermometer etc.
3. To study the dynamic behaviour of U tube manometer representing second order control system by giving impulse input.
4. Determination of damping coefficient and time constant of second order system. 5.To Study the pneumatic control valve and Valve characteristics.
6. To Studythe two tank liquid level non-Interacting systems in series by giving step change and study the overall response.
7. To study the step response of single tank liquid level system.
8. Study of dynamic behaviour and step response of Mercury thermometer during cooling.
9. To study the impulse response of single tank liquid level system.
10. Study of Mixing process in single tank liquid level system and determine time constant.
11. Study of two tank liquid level Interacting systems in series by giving step change and study the overall response.

At least any seven experiment to be conducted.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The students are capable to know about the **basic** theory of various	2

	physical systems and to know actual responses for different inputs for first, second and Interacting non interacting control system.	
2	Students able to **determine** mathematically and graphically time constant, transfer function and response equation by carried out an experiment.	3
3	Students come to **know** how the system behaves with different disturbances and how it can be optimized for stable control system.	2
4	The order of the physical system like first, second and interacting non interacting control system is **determined** experimentally.	3

Course Title: Process Equipment Design & Drawing

Course Code: CHC-417

Theory: 01 Hours/ week **Total Credits:** 01

Course Prerequisite:

Engineering Graphics, engineering and solid mechanics, heat transfer, mass transfer operations, mechanical operations

Course Objectives:

1. To learn the design procedure for designing chemical equipment and selection of proper material of construction by considering different mechanical and physical properties.
2. To know the behaviour of material under stresses.
3. To understand the designing of pressure vessels, high pressure vessels, supports,
4. To do the process design calendria evaporator, shell and tube heat exchanger, sieve tray and bubble cap tray for distillation column, agitators.

Course Contents:

Unit –I

General design procedure for designing chemical equipment, protective coating, corrosion causes and prevention. The material behaviour under stresses.

Unit –II

Unfired pressure vessel subjected to internal and external pressure. Design of shell, nozzle, different types of head. Vessels for high pressure operation, constructional features, multi shell construction, Types of support for vertical and horizontal vessels.

Unit-III

Agitators, selection, types application, power required for agitation, , Process design for short tube calendria Evaporator, shell and tube heat exchanger construction and design in detail. Design for sieve tray and bubble cap tray for distillation column.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Exhibit how to **design** and draw in a competitive manner various process equipment with proper scale and each component with detail dimension.	6
2	Learn how to **design** Pressure vessels, Reaction vessels, Shell and Tube Heat Exchanger, Short Tube Calandria Evaporator.	6
3	**Understand** the constructional features of high-Pressure vessels, detail arrangement of Sieve tray and bubble cap trays.	2
4	Be aware of how to read drawings to **know** details about process equipment, fabrication, maintenance, assembling and dismantling.	2

Reference Books:

1. Sinnott, R. K. Coulson & Richardson's "Chemical Enginering: Volume 6/Chemical Engineering Design", Elsevier Butterworth Heinemann,

2. Joshi, MansukhlaVrajlal, and V. V. Mahajani. Process Equipment Design. Macmillan India,

3. Dawande, S. D. "Process design of equipments." Central Tecno Publication, Nagpur

4 Bhattacharya, B. C. "Introduction of Chemical Equipment Design." Mechanical Aspects

Course Title: Process Equipment Design & Drawing (Lab)

Course Code: CHC-417

Practical (Drawing): 02 Hours/ week **Total Credits:** 01

Course Prerequisite:

Engineering Graphics, engineering and solid mechanics, heat transfer, mass transfer operations, mechanical operations

Course Objectives:

1. To learn the design procedure for designing chemical equipment and selection of propermaterial of construction by considering different mechanical and physical properties.
2. To know the behaviour of material under stresses.
3. To understand the designing of pressure vessels, high pressure vessels, supports,
4. To do the process design calendria evaporator, shell and tube heat exchanger, sieve tray and bubble cap tray for distillation column, agitators.

Course Contents:

Students will be required to do process design and submit drawings of at least six equipments such as pressure vessels, heat exchangers, agitators, short tube calendria type evaporator. Types of agitators, supports. Design of bubble cap tray, sieve tray, different types of packing

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Exhibit how to **design** and draw in a competitive manner various process equipment with proper scale and each component with detail dimension.	6
2	Learn how to draw from the **design** problem solved in theory the exact Drawings of Pressure vessel, Reaction vessel, Shell and Tube Heat Exchanger, Short Tube Calendria Evaporator.	6
3	**Understand** constructional features with help of drawings of high-Pressure vessels, detail arrangement of Sieve tray, bubble cap trays.	2
4	Learn how to read drawings to **know** details about process equipment, fabrication, maintenance, assembling and dismantling.	2

Course Title: Newer Separation Techniques (Elective IV)

Course Code: CHL-424

Theory: 03 Hours/ week **Total Credits:** 03

Course Prerequisite:

Heat transfer, mass transfer operations, and mechanical operations

Course Objective:

1. To learn the various Newer Separation Techniques and cop up with recent advancements in technology.
2. To understand techniques such as adsorption, chromatography, membrane separation, ion exchange methods and advanced separation method in distillation.
3. To compare between the conventional and non-conventional separation methods and their merits and to overcome the difficulties while applying these new techniques commercially.
4. To understand about environmental issues and should provide solutions for green and clean technologies.

Course Content:

Unit –I

Need for newer separation techniques, characterization of separation process.

Adsorption :different types of adsorbents, comparison with conventional methods. Adsorption isotherms.

Unit –II

Elusion Chromatography, retention theory, Chromatography methods for separation such as gas- liquid, liquid-liquid, HPLC, principle, methods and equipments for chromatographic separations. Comparison with other separation methods.

Unit –III

Membrane separation methods such as reverse osmosis, pervaporation, microfiltration, ultrafiltration, electro dialysis etc. industrial application of membranes, membrane materials, their characteristics.

Unit –IV

Ion Exchange: Ion exchange resins, resin capacity, Equilibrium, Exchange Kinetics, Ionexchangeequipments. Industrial application of ion exchange membranes.

Unit –V

Advanced separation methods in Distillation: Azeotropic and extractive distillation, ShortPath distillation, Steam distillation, Reactive distillation.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Apply** Newer Separation Techniques and cop up with recent advances in separation Techniques.	3
2	**Compare** between the traditional mass transfer separation techniques and these alternative and newly developed Techniques.	5
3	**Know** the theoretical principles and practical consideration for adsorption, chromatography, membrane separation, ion exchange methods and advanced separation methods in distillation.	2
4	**Understand** how these techniques are cost effective in terms ofenergy savings and environmentally friendly which provides solution for green andclean technologies.	2

Reference Books:

1. Mass Transfer Operation by Robbert E. Treybal Mc Graw Hills ,
2. Chemical Engineering Vol – II by Richardson and Coulson
3. Distillation by S.L. Pandharipande

Course Title: Fundamentals of Computational Fluid Dynamics

Course Code: CHL-425

Theory: 03 Hours / week (Teaching hours: 03) **Total Credits:** 03

Course Prerequisite: Fluid Mechanics, Heat Transfer, Transport Phenomena, Elementary Numerical Analysis

Course Objectives:

1. To develop an understanding of major theories, approaches and methodologies used in CFD.
2. To build up the skills in the actual implementation of CFD methods.
3. To gain experience in the application of CFD analysis to real engineering designs.

Course Contents:

Unit-I

Introduction to CFD

What is computational fluid dynamics (CFD) and how it works, CFD as design and research tool, impact of CFD in Engineering, basic concepts in fluid dynamics, Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity, laws governing fluid motion, continuity, Navier – stokes & energy equations, boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation, classification of equation of motions – hyperbolic, parabolic, elliptic.

Unit-II

Mathematical Preliminaries

Numerical integration, review of linear algebra, solution of simultaneous linear algebraic equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems; Gauss-Seidel method, successive over relaxation method.

Unit-III

Grid Generation

Transformation of coordinates, general principles of grid generation – structured grids

in two and three dimensions, algebraic grid generation, differential equations based grid generation; elliptic grid generation, algorithm, grid clustering, grid refinement, adaptive grids, moving grids, algorithms, CAD interfaces to grid generation, techniques for complex and large problems: multi block methods.

Unit-IV

Discretization

Introduction to discretization technique, introduction to finite differences: Taylor's series expansion, elementary finite difference coefficients, basic aspects of finite difference equations,consistency, explicit and implicit methods, errors and stability analysis, stability of elliptic and hyperbolic equations, fundamentals of fluid flow modeling, conservative property, upwind scheme, transporting property, higher order up winding, finite difference applications in heat transfer – conduction, convection.

Unit-V

Finite Volume Method

Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretised equations using TDMA, FVM for unsteady problems, explicit schemes, implicit schemes.

Finite Element Method

Introduction, weighted residual and variational formulations, interpolation in one-dimensional and two-dimensional cases, application of FEM to ID and 2D problems in fluid flow and heat transfer.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Understand and be able to numerically **solve** the governing equations for fluid flow.	6
2	Understand and **apply** finite difference, volume and element methods to fluid flow problems.	3
3	Understand how to **assess** stability & conduct a grid-convergence	5

	assessment.	
4	**Develop** perception of major theories, approaches and methodologies used in CFD.	6
5	Understand and **apply** turbulence models and compressible flow solvers to fluid flow problems.	3
6	**Analyse** and apply CFD analysis to solve major engineering design problems involving fluid flow and heat transfer.	4

Reference Books:

- Computational Fluid Dynamics, T. J. Chung, Cambridge University Press.
- Computational Methods for Fluid Dynamics, J. H. Ferziger and M. Peric, Springer.
- Computational Fluid Mechanics and Heat Transfer, John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Taylor &Francis.
- Computational Fluid Dynamics: Principles and Applications, J. Blazek, Elsevier.
- Computational Fluid Dynamics the Basics with Applications, John D Anderson, Jr., McGraw Hill Book Company.
- An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H K Versteeg, W Malalasekera, Pearson Education Ltd.
- Introduction to Computational Fluid Dynamics, Anil W Date, Cambridge University Press.
- Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing Co.
- Computational Fluid Dynamics: A Practical Approach, JiyuanTu, Guan HengYeoh, Chaoqun Liu, Elsevier.
- Principles of Computational Fluid dynamics, Pieter Wesseling, Springer International Edition
- Fundamentals of Computational Fluid Dynamics, Tapan K. Sengupta, Universities Press.

Course Title: Advanced Pharmaceutics (Elective-IV)

Course Code: CHL- 426

Total Hrs/Week: 03 **Course Credit: 03**

Course Objective

1. To understand about different kinetic models
2. To acquaint about solubility and distribution phenomenon
3. To know about different solid, semi solid, liquid dosage forms and aerosols To understand about oral controlled drug delivery system

Course content:

Unit -I

Diffusion, Dissolution, and Distribution Phenomenon: Diffusion: Introduction, Definition, Applications of diffusion, terms used in diffusion. Ficks first law of diffusion, Ficks second law of diffusion. Dissolution: Introduction, Definition, Applications of dissolution, Noyes and Whitney equation. Dissolution studies apparatus {Rotating basket & Paddle type only}. Powder dissolution- Hixson – Crowell cube root law. Distribution coefficient {Nernst coefficient}, True and Apparent Distribution Phase rule – 1 component system {water}; co-solvency.

Unit –II

Pre-formulation Studies: Physicochemical properties of drug molecules and their applications in the development of solid, liquid oral dosage forms. BCS Classification of drug and its significance.

Solid Dosage Forms & Semisolid Dosage Forms

Powders and granules: Manufacturing of powders and granules. Problems occur during manufacturing.

Tablets: Formulation development: types of tablets, properties of drugs such as compressibility, flowability, dose, stability, site of drug release & absorption, additives & factors affecting their selection. Advance granulation techniques like extrusion-spheronization, pelletization, spherical crystallization, fluid bed granulation. Problems occur during manufacturing of tablets.

Coating of Tablets: - Types of coating, Material used & processed employed for each,

coating equipments including different types of coating pans, fluidized bed coating, Defects in coating.

Hard Gelatin& Soft Gelatin Capsules: Introduction, shell excipients, Mfg. of shells, properties of raw materials, environmental controls, evaluation, filling equipments for hard Soft gelatin capsules. In process and finished product quality control tests.

Semisolid Dosage Forms: Emulsion, Gel & Ointment Preparations, Ointments: bases, formulation factors. Manufacturing processes, equipments& packaging.

Unit -III

Liquid Dosage Form:

Solutions: Factors affecting rate of solution, Formulation, Manufacturing process and equipments, Packaging (Glass and plastic containers)

Disperse Systems: Introduction, classification of dispersed system, theories of emulsifications and suspensions-DLVO Theory, vehicles, stabilizers, preservatives wetting agents, emulsifying agents, colours and flavours. HLB values and its determination. Manufacturing and packaging. Problems in manufacturing of disperse systems.

Unit -IV

Aerosols: Introduction, Definition, Advantages, Disadvantages, Applications, Classification. Brief explanation of Propellants & their classes, Application of liquefaction to aerosols *i.e.*, principle of aerosols, mechanism of working of aerosols, Two & Three Phase systems. Quality control and stability studies.

Unit –V

Oral controlled Drug delivery system

Introduction – Designing oral controlled drug delivery system and Factors considering controlled drug delivery approach, Release kinetic for oral controlled drug delivery system, Strategies and Technologies – Microencapsulation, Osmotically controlled drug delivery, Rate controlling matrix, Coating, Multilayer tablets, Gastro retentive approaches for controlled release (High density, floating, bioadhesive/mucoadhesive, Expendables, superporous hydrogel), Pulsatile drug delivery.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the different laws and kinetic models	2
2	**Understand** about solubility and distribution phenomenon	2
3	**Understand** about different solid, semi solid, liquid dosage forms and aerosols	2
4	**Understand** about oral controlled drug delivery system	2

Reference Book:

1. Theory and Practice of Industrial Pharmacy:Leon Lachman 1986
2. Martin's Physical Pharmacy and Pharmaceutical Sciences: Patrick J. Sinko, Yashveer Singh First Edition
3. Handbook of Pharmaceutical Manufacturing Formulations, Second Edition: Sarfaraz K. Niazi
4. Remington, The Science and Practice of Pharmacy Twenty First Edition
5. Modern Pharmaceutics: Gilbert S. Banker, Christopher T. Rhodes CRC Press, 2002
6. Theory and Practice of Industrial Pharmacy: Herbert A. Led and Febiger Joseph L. 1986
7. Misra, A. and Shahiwala, A. eds., 2019. Novel Drug Delivery Technologies: Innovative Strategies for Drug Re-positioning. Springer Nature.

Eighth Semester

Course Title: Industrial Training/ Project

Course Code: CHP- 418

Total Hrs/Week: 24 **Course Credit:** 12

Course Objective:

To nurture the interest of graduates in research with subject knowledge they have acquired earlier

To get exposure about recent industrial practices and technological revolutions

To get exposure for data compilation and report writing of their research work

Course Content:

Industrial Training/ Project

Research Project at Department: The entire semester will be devoted for the detail experimental work on a research problem from the field of Chemical Engineering selected by the student and specially approved by the faculty member/s designated as research guide/s. The student will present his/her findings in the form of neatly typed and bound thesis and will have to appear before panel of experts for defending his/her Thesis.

OR

Research Project/ Training at Industry: The student will undertake research work/ Training at selected reputed Institute / Industries for six months on a topic allotted by the concerned institute / Industry Management and approved by the Department. His/her progress will be jointly reviewed by the Department and the concerned Institute / Industry Management. The student will present his/her findings in the form of neatly typed and bound thesis, which will carry approval and attendance certificate issued by the concerned Industry Management and will have to appear before panel of experts for defending his/her Thesis.

Course Outcomes:

Upon successful completion of Industrial Training, Technocrat will develop skills & good practices related to

CO No.	Course Outcome	Cognitive level
1	Increase awareness in the field of Chemical Engineering and Technology.	2

2	**Identification** of raw materials, material selection, performance criteria, applicable processing method, product defects, their practical causes and remedies.	2
3	Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.	2
4	Career opportunities and Choices.	2

Course Code: CHP- 418

Course Title: Technical Seminar & Colloquium

Total Hrs/Week: 06 **Course Credit: 03**

Course Objective:

The students will develop necessary skills in understanding current trends in the field of Chemical Engineering and Technology. Graduates will get an in-depth exposure of literature survey, preparing technical review report. It will also lead to improvement of technical presentation skills of the graduates. It will be immensely helpful in upliftment of young technocrats from institute to industry. The students get molded in such a fashion that they can easily adapt to the industrial environment. It also helps the budding engineers in inculcation of corporate ethics & culture as a part of their behaviour.

Course Content:

1. Critical review of selected topics in Chemical Engineering and allied subjects
2. Standard typed report under the supervision of Guide.
3. Oral presentation of the report before panel of experts

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Knowledge** of recent and emerging trends in the field of Chemical Engineering and Technology.	2
2	Ability to **identify** and **solve** technical problems.	3
3	**Development** of soft skills required to enhance presentation abilities.	6
4	**Recognition** of the need for, and an ability to engage in life-long learning.	1