Course Structure & Syllabus

of

B. Tech. Programme

in

Chemical Engineering

Academic Year – 2019-20

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA,

Sambalpur, Odisha-768018

www.vssut.ac.in

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA, ODISHA
DEPARTMENT OF CHEMICAL ENGINEERING

VISION

To become a nationally and internationally acclaimed department of higher studies and to prepare the students to meet new challenges faced by chemical and related industries through green technologies.

MISSION

1. To import strong fundamental knowledge to the students to face the new world in a rapidly changing technological environment.
2. To carry out interdisciplinary research so as to address the needs of chemical engineering in particular and society in general.
3. To develop leadership qualities in the students to solve chemical engineering problems keeping in mind the safety and environmental concerns.

Programme Educational Objectives (PEOs) for UG Programme:

Graduates from the **Chemical Engineering program** are expected to achieve the following Program Educational Objectives within four years of graduation:

PEO1	The graduates will be able to meet the current and future demands of technical manpower in the chemical industry and will be able to pursue post-graduation and cutting-edge research in chemical engineering and allied engineering disciplines.
PEO2	The graduates will acquire a solid foundation in mathematical, scientific and engineering fundamentals required to formulate, analyse and solve chemical engineering and related problems.
PEO3	The graduates will be able to undertake design development, production, managerial and entrepreneurial activities in the fields of chemical engineering including techno-economic feasibility of the process.
PEO4	The Graduates will recognize the importance of utilizing their knowledge, skills, and initiative for the benefit of society and demonstrate that understanding through their interactions within their community, in government, or in society as a whole.
PEO5	Graduates will assume positions of leadership and will be committed to lifelong learning throughout their careers

PEO-MISSION MATRIX

	M1	M2	M3
PEO1	3	1	1
PEO2	1	3	2
PEO3	2	2	3
PEO4	1	3	3
PEO5	2	3	3

Programme outcome (PO)

At the end of the Programme, a Chemical Engineering graduate will be able to

PO1	Demonstrate and apply the knowledge of the fundamentals of chemistry, physics, mathematics, and applied sciences and will be able to formulate, analyse, and solve chemical engineering problems.
PO2	Demonstrate and apply the knowledge of fundamental principles such as laws of conservation, their applications, physical and chemical equilibria, transport and rate processes, separation processes, chemical process control, reaction engineering, non-conventional energy sources, Bioprocess engineering, catalysis and Polymer Science and Technology.
PO3	Design Chemical Process Equipment, do detailed process plant engineering, piping, utilities, etc., determine process feasibility and viability with respect to economic aspects, process and environmental safety and social aspects etc.
PO4	Have an advanced knowledge of fundamental areas of chemical engineering, such as bioprocess engineering, advanced separation processes, mathematical modelling, simulation and optimization of chemical processes and henceforth will be able to solve cutting-edge chemical engineering problems.
PO5	Use latest computer technology, computer aided simulation software packages to solve complex chemical process engineering problems.
PO6	Participate in seminars, projects, case studies and research projects and develop an understanding of how to undertake research, design & development in cutting edge areas.
PO7	Possess the ability to write coherent, concise, and accurate technical reports, compile data and give technical, concise, effective oral presentations acquiring good communication skills during course of study.
PO8	Learn how to provide solutions by applying problem-solving skills, particularly with regard to problem definition, team-work, project organization and delivery of project objectives within the constraints imposed by time and available information.
PO9	Develop leadership qualities whenever working in a group and while handling multi

	disciplining engineering projects.
PO10	Communicate effectively among engineering community
PO11	Provide environmental friendly and sustainable engineering projects involving multidisciplinary aspects/ streams including its financial cost estimation etc.
PO12	Have aptitude for learning new innovative technologies in chemical and allied fields of chemical Engineering or pursue advanced studies.

Programme specific outcome (PSO)

PSO1	The students of the programme will acquire a strong foundation in mathematics, basic sciences and chemical engineering to meet the current demands in the professional world with cutting-edge research in chemical and allied engineering disciplines.
PSO2	Graduates would be equipped with a working knowledge in professional courses such as process economics, project engineering, industrial safety and sustainable development to work in the conventional as well as frontier area of Chemical Engineering which enables them suitable for chemical industries.
PSO3	Graduates of chemical engineering will be able to communicate in a professional setting, including soft skills, technical writing, presentation, and management skills making them employable to industries.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY BURLA ODISHA
PROPOSED COURSE STRUCTURE FOR BACHELOR OF TECHNOLOGY (CHEMICAL ENGG.)
COURSES TO BE EFFECTIVE FROM JULY/AUGUST 2020

COURSE STRUCTURE FIRST SEMESTER		**FIRST YEAR (THEORY)**		
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credits**
1	BMA 01001	Mathematics-I	3-1-0	4
2	BPH 01001	Engineering Physics	3-0-0	3
3	BEE 01001	Basic Electrical Engg.	3-0-0	3
4	BHU 01001	English For Business Communication	3-0-0	3
5	BME 01001	Engineering Mechanics	3-0-0	3
SESSIONALS				
1	BPH 01002	Physics Laboratory	0-0-3	1.5
2	BEE 01002	Basic Electrical Engg. Lab	0-0-3	1.5
3	BHU 01002	Business Communication and Presentation Skill Lab	0-0-3	1.5
4	BME 01002	Workshop & Manufacturing Practices	0-0-3	1.5
NON-CREDIT				
1	BNC 01003	Induction Programme and participation in Clubs / Societies	0-0-0	0
Total			15-1-12	22

COURSE STRUCTURE SECOND SEMESTER		**FIRST YEAR (THEORY)**		
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credits**
1	BMA 02001	Mathematics - II	3-1-0	4
2	BCH 02001	Chemistry	3-0-0	3
3	BEC 02001	Basic Electronics	3-0-0	3
4	BIT 02001	Programming for Problem Solving	3-0-0	3
5	BME 02001	Basic Civil Engg.	3-0-0	3
SESSIONALS				
1	BCH 02002	Chemistry Lab	0-0-3	1.5
2	BEC 02002	Basic Electronics Lab	0-0-3	1.5
3	BIT 02002	Programming Lab /	0-0-3	1.5
4	BCE 02002	Engineering Graphics & Design	0-0-3	1.5
NON-CREDIT				
1	BNC 02003	NSS/NCC/Yoga	0-0-0	0
Total			15-1-12	22

COURSE STRUCTURE SECOND YEAR		THIRD SEMESTER (THEORY)		
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Total Credits**
1	BMA 03001	Mathematics-III	3-1-0	4
2	BCM 03001	Fluid Mechanics	3-0-0	3
3	BCM 03002	Chemical Process Calculation	3-0-0	3
4	BCM 03003	Coal Processing Technology	3-0-0	3
5	BHU 03001	Economics for Engineers	3-0-0	3
SESSIONAL				
1	BCM 03004	Fuel Technology – I Lab.	0-0-3	1.5
2	BCM 03005	Fluid Mechanics –I Lab.	0-0-3	1.5
3	BCM 03006	Process Technology Lab.	0-0-3	1.5
4	BCM 03007	Environmental Engineering Lab.	0-0-3	1.5
NON-CREDIT				
1	BNC 03001	Essence of India Traditional Knowledge/ Environmental Sciences	0-0-0	0
Total			14-1-12	21

COURSE STRUCTURE SECOND YEAR		FOURTH SEMESTER (THEORY)		
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	BMA 04001	Mathematics-IV	3-0-0	4
2	BCM 04001	Fuels and Combustion	3-1-0	3
3	BCM 04002	Mechanical Operation	3-0-0	3
4	BCM 04003	Chemical Engineering Thermodynamics	3-0-0	3
5	BHU 04001	Organisational Behaviour	3-0-0	3
SESSIONALS				
1	BCM 04004	Fuel Technology- II Lab.	0-0-3	1.5
2	BCM 04005	Mechanical Operations Lab.	0-0-3	1.5
3	BCM 04006	Fluid Mechanics –II Lab.	0-0-3	1.5
4	BCM 04007	Chemical Engineering Thermodynamics Lab.	0-0-3	1.5
NON-CREDIT				
1	BNC 04001	Environmental Sciences/ Essence of India Traditional Knowledge	0-0-0	0
2	BNC 04002	Summer Internship/ Training	0-0-0	0
Total			14-1-12	21

COURSE STRUCTURE THIRD YEAR		FIFTH SEMESTER (THEORY)		
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	BCM 05001	Heat Transfer	3-0-0	3
2	BCM 05002	Mass Transfer-I	3-0-0	3
3	BCM 05003	Chemical Reaction Engg.- I	3-0-0	3
4		Professional Elective -I	3-0-0	3
5		Open Elective -I	3-0-0	3
6		Professional Ethics, Professional Law & Human Values/ Financial Management, Costing, Accounting, Balance Sheet & Ratio Analysis	2-0-0	2
SESSIONAL				
1	BCM 05004	Heat Transfer Lab.	0-0-3	1.5
2	BCM 05005	Mass Transfer Lab.	0-0-3	1.5
3	BCM 05006	Chemical Reaction Engg. Lab.	0-0-3	1.5
Total			17-0-9	21.5

COURSE STRUCTURE THIRD YEAR		SIXTH SEMESTER (THEORY)		
SI. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	BCM 06001	Mass Transfer-II	3-0-0	3
2	BCM 06002	Process Dynamics and Control	3-0-0	3
3		Professional Elective -II	3-0-0	3
4		Professional Elective-III	3-0-0	3
5		Open Elective-II	3-0-0	3
6		Financial Management Costing, Accounting, Balance Sheet & Ratio Analysis/Professional Ethics, Professional Law & Human Values	2-0-0	2
SESSIONALS				
1	BCM 06003	Computer Aided Design Laboratory	0-0-3	1.5
2	BCM 06004	Process Control Lab.	0-0-3	1.5
3	BCM 06005	Process Equipment Design Lab.	0-0-3	1.5
NON-CREDIT				
1	BNC 06001	Summer Industry Internship/ Training/ Project	0-0-0	0
Total			17-0-9	21.5

COURSE STRUCTURE FOURTH YEAR		SEVENTH SEMESTER (THEORY)		
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	BCM 07001	Process Simulation and Modelling	3-0-0	3
2	BCM 07002	Petroleum Refinery Engineering	3-0-0	3
4		Professional Elective-IV	3-0-0	3
5		Open Elective-III	3-0-0	3
SESSIONALS				
1		Project - I	0-0-6	3
2	BCM 07003	Process Simulation Lab.	0-0-3	1.5
3		Seminar on internship	0-0-3	1.5
Total			12-0-12	18

COURSE STRUCTURE FOURTH YEAR		EIGHTH SEMESTER (THEORY)		
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1		Professional Elective-V	3-0-0	3
2		Professional Elective-VI	3-0-0	3
3		Open Elective-IV	3-0-0	3
SESSIONALS				
1		Project II	0-0-12	6
2		Seminar on Project	0-0-2	1
Total			9-0-14	16

Note: Each hour of practical /lab/ Sessional class = 0.5 credit
The students should undergo Summer Internship or Project in India or Abroad for a minimum period of 8 weeks either in 4^{th}& 6^{th} Semesters together or in one semester at a stretch.

List of Professional Electives (Third Year)			
Sl. No	**Category**	**Course Code**	**Subject Name**
1	Professional Elective-I	BCMPE 501	Chemical Process Technology
2		BCMPE 502	Chemical reaction engineering-II
3		BCMPE 503	Polymer Science & Technology
4		BCMPE 504	Paper & Pulp Technology
1	Professional Elective-II	BCMPE 601	Transport Phenomena
2		BCMPE602	Bio-Materials
3		BCMPE 603	Nanotechnology in catalysis
4		BCMPE 604	Fertiliser Technology
1	Professional Elective-III	BCMPE 605	Process Equipment Design
2		BCMPE 606	Disaster Management in Chemical Industry
3		BCMPE 607	Food Biotechnology
4		BCMPE 608	Material Science & Engineering

List of Professional Electives (Final Year)			
Sl. No	**Category**	**Course Code**	**Subject Name**
1	Professional Elective-IV	BCMPE 701	Mineral Process Engineering
2		BCMPE 702	Corrosion and Degradation of Materials
3		BCMPE 703	Particulate Science and Technology
4		BCMPE 704	Membrane Technology
1	Professional Elective-V	BCMPE 801	Fluidisation Engineering
2		BCMPE 802	Wastewater Management
3		BCMPE 803	Colloidal & Interfacial Engineering
4		BCMPE 804	Chemical Technology-II
1	Professional Elective-VI	BCMPE 805	Modern separation Techniques
2		BCMPE 806	Process Instrumentation
3		BCMPE 807	Bio-Energy Engineering
4		BCMPE 808	Project Engineering

List of Open elective subjects:

Course Code	**Course Code**	**Open Elective Subjects**	**Department To Offer**
Open Elective-I	BCMOE 501	Industrial Pollution Control	CE/ME/MME/PE
Open Elective-II	BCMOE 601	Characterization Techniques	ME/MME/CE/PE
Open Elective-III	BCMOE 701	Renewable Energy	EE/CE/MME/ME
Open Elective-IV	BCMOE 801	Optimization Techniques	CE/ME/PE/MME

DETAILED SYLLABUS

1st Semester

Mathematics-I (Calculus and Linear Algebra) (BMA01001) [3-1-0]

Module-I: Calculus (8 Hours)

Rolle's Theorem, Mean value theorems (statements only) and applications. Introduction proper integrals. Beta and Gamma functions and their properties

Module-II: Calculus (8 Hours)

Convergence of sequence and series, tests of convergence. Fourier series, arbitrary period, even and odd function, half range series.

Module-III: Calculus (8 Hours)

Limit continuity and partial derivatives (two variables), maxima and minima. Vector and scalar point functions and fields, gradient of a scalar field, directional derivative, divergence of a vector field, curl of a vector field and applications

Module-IV: Linear Algebra (8 Hours)

Linear systems of equations, Gauss elimination, linear independence, rank of a matrix, auss-Jordan elimination. Vector Space; basis and dimension'

Module-V: Linear Algebra (8 Hours)

Eigen values, eigen vectors, some applications of eigen value problems, symmetric, skew- symmetric and orthogonal matrices, diagonalization, quadratic forms, complex matrices and forms.

Text Book:

1) ErwinKreyszig,AdvancedEngineeringMathematics(9thEdition),WileyIndiaPvt .Ltd
2) S.C. Malik and S. Arora, Mathematical Analysis, New Age International

Reference Books:

1) George B. Thomas, Jr .and Ross L.Finney,CalculusandAnalyticGeometry,Addison Wesley Publishing Company
2) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
3) A. Stroud, Advanced Engineering Mathematics, Industrial Press
4) S.K. Paikray, Text book of Matrix Algebra, Kalyani Publisher

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Recognize basic knowledge of differential calculus, improper integral, Beta and Gamma functions which are useful in various fields of engineering
CO2	Analyse periodic phenomenon and describe Fourier series expansion of periodic function
CO3	Demonstrate functions of several variables that is essential in most of the branches of engineering
CO4	Apply Gauss elimination method and rank of a matrix in solving linear equations
CO5	Implement knowledge of eigen values and eigen vectors in a comprehensive manner

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

ENGINEERING PHYSICS (BPH01001)

Module-I: Properties of Matter

Ideas of Elastic Constants (Y, K, η and σ), relation between elastic constants, torsion pendulum, determination of η, cantilever at one end.

Module-II: Oscillation and waves

Review of Simple Harmonic Oscillation and application to Compound pendulum, Damped Harmonic Oscillation, Forced Oscillation, Resonance (Amplitude Resonance, Velocity Resonance, and Sharpness of Resonance).

Module-III: Optics

Concept of Wave and wave equation, Superposition of Many harmonic waves, Interference, Concept of coherent sources (Division of wave front and division of amplitude), Interference in thin parallel film, Newton's ring (Theory, Application, Determination of Wave length of Light, Refractive index of liquid), Concept of Diffraction (Huygen's Principle),Types of Diffraction, Fraunhofer Diffraction due to a single slit and diffraction Grating, Determination of Wave length, Dispersive Power and Resolving Power of a Plane Diffraction Grating, Polarization, Double Refraction, Half wave Plate, Quarter wave Plate.

Module-IV: Electromagnetism

Vector Calculus, Gradient, Divergence, Curl (Mathematical Concept), Gauss' Divergence Theorem and Stoke's Theorem (Statement Only), Derivation of Maxwell's Electromagnetic Equations in Differential form and Integral form, Electromagnetic Wave equations for E and B in vacuum and in conducting medium, Transverse nature of EM waves.

Module-V: Quantum Mechanics and Photonics

Wave particle duality, Matter Wave (de-Broglie Hypothesis), Wave Functions, Observables as Operators, Eigen Functions and Eigen Values, Normalization, Expectation Values, Schrodinger equation (Time Dependent and Time Independent), Particle in a box. Lasers: Introduction and Characteristics of Lasers, Einstein's Coefficients and Relation between them, Lasing Action (Population Inversion, Three and Four Level Pumping Schemes), Different types of Lasers (Ruby lasers, He-Ne Lasers).

Text Book:

1. Principle of Engg. Physics: Md. N. Khan and S. Panigrahi
2. Engg. Physics: H.K. Malik and A.K. Singh

Reference Books:

1. Oscillations and Waves: N. Subramanyam and BrijLal

2. Optics: A. Ghatak
3. Electrodynamics: D.J. Griffith
4. Concept of Modern Physics: A. Beiser
5. Lasers: Theory and Applications: K. Thyagarajan and A.K. Ghatak

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Explain the concepts of Stress, Strain, Elastic Modulus and Elastic Constant, Bending of Beams. Identify the importance Elastic properties in Engineering Applications
CO2	Understand simple harmonic Oscillator, Damped Harmonic and Forced Oscillators. Explain Quality factor and resonance with applications
CO3	Explain the link between Simple Harmonic Motion and Waves. Understand the principle of superposition, the need of coherent sources, analyze the difference between Interference and Diffraction and their applications. Illustrate the concept of Polarization of light and its applications.
CO4	Understand the basic mathematical concepts related to electromagnetic vector fields, Understand the concepts related to electromagnetic wave.
CO5	Understand and explain the differences between classical and quantum mechanics. Interpret the wave function, operators and Schrodinger equation to solve physical problems. Understand generation, outline and need for the laser

Course Articulation Matrix row for this Course

Table	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	POP11	PO12
CO1	3	3	2	2	1	-	-	1	-	1	-	1
CO2	3	3	3	2	1	-	-	1	-	1	-	2
CO3	3	3	3	3	1	-	-	1	-	1	-	2
CO4	3	3	3	2	1	-	-	1	-	1	-	2
CO5	3	3	2	3	2	-	-	2	-	2	-	2

Program Articulation Matrix row for this Course:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

BASIC ELECTRICAL ENGINEERING (BEE01001)

Module-I (8 Hours)

D.C circuit analysis and network theorems: Concept of network, Active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, source transformation, Kirchoff's Law: loop and nodal methods of analysis, star delta transformation, network theorems: Thevenin's theorem, Norton's theorem, maximum power transfer theorem. Transients, in R-L, R-C and R-L-C circuits with DC Excitation.

Module-II (8 Hours)

Single phase and three phase ac circuit: Sinusoidal, square and triangular aveforms-average and effective value, form the peak factors, concept of phasors, phasorsre presentation of sinusoidally varying voltage and current, analysis of series-parallel RLC circuits. Apparent, active and reactive powers, power factor, power factor improvement, resonance in series and parallel circuits, band width and quality factors, star and delta connections, balanced supply and balanced load, line and phase voltage/current relation, three phase power measurements.

Module-III (8 Hours)

Magnet circuit & principle of electromechanical energy conversion: Analogy between electric and magnetic circuit, magnetic circuits with DC and AC excitation, magnetic leakage, BH curve, hysteresis and eddy current losses, magnetic circuit calculation, mutual coupling. Principles of dc motor & generator, types, emf equation of DC machine, torque equation of motor, Speed control of dc motor. Characteristics and applications of DC motors.

Module-IV (8 Hours)

AC MACHINES: Single Phase Transformer: Principle of operation, construction, emf equation, equivalent circuit, power losses, efficiency, Introduction to autotransformers. Three Phase Induction Motor: Type, principle of operation, slip-torque Characteristics, applications. Single Phase Induction Motor: Principle of operation and introduction to methods of starting, applications. Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor, emf equation, voltage regulation, applications.

Module-V (7 Hours)

Measurement Instruments & Introduction to Power System: Types of instruments: construction and working principle of PMMC and MI type voltmeter and ammeters, single phase dynamometer type wattmeter and induction type energy meter, use of shunts and multipliers: general layout of electrical power system and function of its elements, concept of grid, Introduction to power converters.

TEXT BOOKS

[1] Edward Hughes (revised by Ian Mc Kenzie Smith), "Electrical & Electronics Technology", Pearson Education Limited. Indian Reprint2002, 10th Edition.

[2] D. Kulshreshtha, "Basic Electrical Engineering" TMH,1stEdition.

REFERENCE BOOKS

[1] C.L. Wadhwa, "Electrical Engineering", New AgeInternationalPublishers,2nd Edition.
[2] S. Parker Smith, "Problems in Electrical Engineering", Asia Publications,10thEdition.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement principles of DC network, theorems and transients.
CO2	Analyze the concept of Single phase and three phase AC circuits.
CO3	Express the concept of magnetic circuit and DC machines.
CO4	Apply basic principles of AC machines and their working.
CO5	Demonstrate basic principles of measuring instruments and power system.

Course Articulation Matrix

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1
CO	3	3	2	1	1	2	1	-	-	-	-	1
CO	3	3	2	1	1	2	1	-	-	-	-	1
CO	3	3	2	1	1	2	1	-	-	-	-	1
CO	3	3	2	1	1	2	1	-	-	-	-	1
CO	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate(Medium) 3: Substantial (High) -:No Correlation

Program Articulation Matrix row for this Course

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1
Course	3	3	2	1	1	2	1	-	-	-	-	1

ENGLISH FOR BUSINESS COMMUNICATION (BHU01001)

Module-I: Fundamentals of Communication (6 Hours)

- Process of Communication, Types of Communication (Verbal & Non Verbal)
- Channels of Business Communication
- Barriers to Communication.
- Plain English
- Bias free language
- Cross Cultural Communication

Module-II: Communicative Grammar (6 Hours)

- Time and Tense
- Aspects (Perfective & Progressive)
- Verbs of State and Event
- Passive and Active Voice
- Conditionals

Module-III: Sounds of English (6 Hours)

- The Speech Mechanism and Organs of Speech
- Consonant Sounds of English
- Vowel Sounds of English
- Stress Pattern: Syllable, Stress and Intonation.
- Problem sounds for Indian Speakers

Module-IV: Business Writing (6 Hours)

- Paragraph writing
- Sentence Linker
- Business Letters
- Report Writing
- Proposal writing

Module-V: Professional Writing (6 Hours)

- Notice, Circular and Memo writing
- Agenda& Minute writing
- Writing Cover letter
- Résumé (CV) Writing

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata Mc Graw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
3. Better English Pronunciations by J.D.O Conner (Cambridge University Press)
4. A Communicative Grammar of English by G.N.Leech andJan Svartik(OUP)
5. Business communication by Ramachandran, Lakshmi and Krishna (Macmillan)

Course Outcomes

Upon completion of the course the students will demonstrate the ability to:

CO1	Analyse various components of human communication and to identify key elements and principles of organizational communication.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Evaluate students' ability to articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Write various business documents appropriate for different business and employment situations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	1	-	1	-	-	1	3	-	-
CO2	-	-	-	1	-	1	-	-	1	3	-	-
CO3	-	-	-	1	-	1	-	-	1	3	-	-
CO4	-	-	-	1	-	1	-	-	1	3	-	-
CO5	-	-	-	1	-	1	-	-	1	3	-	-

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	-	-	-	-	-	-	-	-	1	3	1	-

ENGINEERING MECHANICS (BME01001)

Module-I (8 Hours)

Concurrent forces on a plane: Composition, resolution and equilibrium of concurrent coplanar forces, method of moment. General case of forces on a plane: Composition and equilibrium of forces in a plane, plane trusses, method of joints and method of sections, plane frame, equilibrium of ideal systems.

Module-II (8 Hours)

Friction: Problems involving dry friction, Ladder, Wedges Principle of virtual work.

Module –III (8 Hours)

Parallel forces on a plane: General case of parallel forces, center of parallel forces and center of gravity, centroid of composite plane figure and curves, Theorems of Pappus.

Moments of inertia: Plane figure with respect to an axis in its plane and perpendicular to the plane, Polar moment of inertia, parallel axis theorem

Module –IV (8 Hours)

Rectilinear translation: Kinematics, principle of dynamics, D Alembert's Principle,

Principle of work and energy for a particle and a rigid body in plane motion, Conservation of energy, Principle of impulse and momentum for a particle and a rigid bodies in plane motion, Conservation of momentum, System of rigid bodies, Impact, direct and central impact, coefficient of restitution.

Module –V (8 Hours)

Curvilinear translation: Kinematics, equation of motion, projectile, D Alembert's principle of curvilinear motion. Kinematics of rotation of rigid body.

Text Book:

1. Engineering Mechanics: S Timoshenko &Young; 4thEdition (International edition) Mc Graw Hill.

Reference Books:

1. Fundamental of Engineering mechanics (2nd Edition): S Rajesekharan& G Shankara Subramanium Vikas Pub. House Pvt ltd.
2. Engineering Mechanics: K. L. Kumar; Tata MC Graw Hill.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Draw free body diagrams and deter mine the resultant of forces and/or moments.
CO2	Solve the problems involving dry friction.
CO3	Deter mine the centroid and second moment of area of sections.
CO4	Apply Newton's laws and conservation laws to elastic collisions and motion of rigid bodies.
CO5	Determine the various parameters in projectile motion.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	-	3	1	-	1
CO2	3	3	2	1	2	-	-	-	3	1	-	1
CO3	3	3	2	1	2	-	-	-	3	1	-	1
CO4	3	3	2	1	2	-	-	-	3	1	-	1
CO5	3	3	2	1	2	-	-	-	3	1	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-:No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	-	-	-	3	1	-	1

SESSIONALS

PHYSICS LABORATORY (BPH01002)

List of Experiments:

1. Determination of acceleration due to gravity by using Bar pendulum
2. Determination of surface tension of water by capillary rise method
3. To draw the characteristics of a bipolar junction transistor
4. To determine the rigidity modulus of the material of a wire by using Barton's apparatus.
5. Determination of wave length of monochromatic light with the help of Newton's ring apparatus.
6. Determination of grating element of a diffraction grating using spectrometer.

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Express the idea of calculation of acceleration due to gravity any place using the concept of oscillatory system and simple harmonic motion.
CO2	Demonstrate the working and operational technique to calculate the mechanical properties of fluid and other materials.
CO3	Evaluate the voltage, current, power and characteristics behaviour of the electronic devices.
CO4	Analyze the mechanical properties of any material with the idea of elasticity and its various applications.
CO5	Implement the measurement of different characteristic properties and related calculations of optical devices.

Course Articulation Matrix

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) -:No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

BASIC ELECTRICAL ENGINEERING LABORATORY (BEE01002)

List of Experiments:

1. Preliminary: Preparation of symbol chart for various systems & components as per ISS, to study the constructional & operational features for Voltmeter, Ammeter, Wattmeter, Frequency meter, multi-meter and Rheostat, Study of safety rules as per ISS.
2. Measurement of the armature & field resistance of D.C. Machine by volt-amp method. & Starting and speed control of a D.C. shunt motor
3. Study of BH Curve
4. Determination of open circuit characteristics (O.C.C) of D.C shunt generator when separately excited at different speeds.
5. Measurement of earth resistance and insulation resistance.
6. Starting of Induction motor and measurement of three phase power & power factor by 2-wattmeter method.
7. Calibration of a single phase Energy Meter by directed loading &Phantom loading.
8. Obtaining the voltage, current, power and power factor of fluorescent lamp.
9. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging-slip ring arrangement) and single-phase induction machine.
10. Demonstration of(a)dc-dc converters(b)dc-ac converters –PWM waveform

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Express the safety rules as per ISS and symbols of different electrical components and the use of various electrical instruments in laboratory.
CO2	Demonstrate the working and operational characteristics of dc motor and dc generator.
CO3	Evaluate the voltage, current, power and power factor of fluorescent lamp.
CO4	Implement the measurement of earth resistance and insulation resistance and demonstrate the internal structure of different machines.
CO5	Analyze the connection and calibration of single phase energy meter, three phase power and power factor by two wattmeter method and basic idea about converters.

Course Articulation Matrix

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1
CO	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) -:No Correlation

Program Articulation Matrix row for this Course

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1
Course	3	3	2	1	3	2	1	1	3	3	1	1

BUSINESS COMMUNICATION AND PRESENTATION SKILLS LAB (BHU01002)

1. Functional English grammar: Practice and exercises
2. Practice of English phonemes
3. Reading comprehension
4. Drafting business correspondence
5. Understanding the importance of body language
6. Oral presentations (Self Introduction, Extempore, Formal Presentation, power point presentations etc.)
7. Group discussion
8. Preparation for appearing an interview
9. Situational conversation practice

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
3. Better English Pronunciations by J.D.O Conner (Cambridge University Press)
4. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP)
5. Business communication by Ramachandran, Lakshmi and Krishna (Macmillan)

Course Outcomes

Upon completion of the sessional the students will demonstrate the ability to:

CO1	Analyse various components of effective human communication and to apply them during various practice sessions.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Confidently face various recruitment drives and qualify them.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	1	3	-	-
CO2	-	-	-	-	-	1	-	-	1	3	-	-
CO3	-	-	-	-	-	1	-	-	1	3	-	-
CO4	-	-	-	-	-	1	-	-	1	3	-	-
CO5	-	-	-	-	-	1	-	-	1	3	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -:No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	-	-	-	-	-	-	-	-	1	3	1	-

WORKSHOP & MANUFACTURING PRACTICES (BME01002)

1. **Carpentry Section**:
   Study of different Hand tools, measuring instruments and equipments used in Carpentry work. Safety precautions.

Preparation of Job:

Wooden rack/bench/chair/stool (anyone)

Includes the operations:

Measuring, Marking, Sawing, Planning, Chiseling, Mortesing, Tenoning, making Half-lap joint, Mortese & Tenon joint and Nail joint.

2. **Fitting Section**:
   Study of different Hand tools, measuring instruments and equipments used in Fitting work. Safety precautions. Study of Drilling Machine and Grinding Machine.

Preparation of Job:

Paper Wt. /Square or Rectangular joint (male-female joint) (any one)

Includes the operations:

Measuring, Marking, Filing, Sawing, Drilling, Tapping, Dieing and Punching.

3. **Black Smith Section**:
   Study of different Hand tools, equipments, Open hearth furnace and Induction furnaces used in Blacksmith work. Different types of heat treatment processes. Safety precautions.

Preparation of Job:

Weeding hook/Hexagonal headed bolt/Chisel (anyone)

Includes the operations:

Measuring, Marking, Cutting, Upsetting, Drawing down, Bending, Fullering and Quenching.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Acquire knowledge on different types of hand tool, measuring instruments and machine tools are used in Fitting, Carpentry and Smithy work.
CO2	Know about different types of operations and joints performed in different shops i.e. in Fitting and Carpentry.
CO3	Know about the forging temperature of different types of ferrous metals and Different types of operation (e.g. upsetting, edging, flattening and bending etc.)Carried out on hot metals to prepare jobs.
CO4	Acquire skills for the preparation of different types of jobs Carpentry/ fitting/ smithy shops by using different types of hand tools and machine tools.
CO5	Understand the importance of safety precaution in different shops.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	2	2	1	1	3	1	2	1
CO2	-	-	1	-	2	2	1	1	3	1	2	1
CO3	-	-	-	-	1	2	1	2	3	1	2	1
CO4	-	-	-	-	3	2	1	1	3	1	2	1
CO5	-	-	-	-	-	-	-	1	2	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	1	-	2	2	1	1	3	1	2	1

2ND SEMESTER

Mathematics-II (Differential Equations and Complex Variables (BMA02001)
Module-I: Differential Equations (8 Hours)

Exact ODEs, integrating factors, linear ODEs, Bernoulli equation, homogeneous linear odes of second order, homogeneous linear ODEs with constant coefficients, Euler-Cauchy equations, non-homogeneous ODEs, Applications of ODEs to electric circuits

Module-II: Power Series Solution of Differential Equations (8 Hours)

Series solution of differential equation (excluding Frobenius method), Legendre equation, Legendre polynomials. Bessel's Equation, properties of Bessel's functions, Bessel Functions of the first and Second Kind.

Module-III: Complex Variables (8 Hours)

Complex valued function, differentiation, analytic function, Cauchy-Riemann equations, harmonic and conjugate harmonic functions, exponential function, trigonometric and hyperbolic Functions, logarithm, general power

Module-IV: Complex Variables (8 Hours)

Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, power series, radius of convergence, Taylor and Maclaurin series, singularities and zeros, Laurent series, cauchy residue theorem (statement only) and applications.

Module-V: Elementary Numerical Methods (8 Hours)

Solution of algebraic and transcendental equations by Newton-Raphson and secant method.

Interpolation: Lagrange's method, divided difference method, Newton's forward and backward method. Numerical Integration: Trapezoidal and Simpson's Rule. Numerical solutions of differential equations: Euler's method and improved Euler's method.

Text Book:

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition.

Reference Books:

1) K. A. Stroud, Advanced Engineering Mathematics, Industrial Press
2) MiltonAbramowitzandIreneA.Stegun,HandbookofMathematicalFunctions,NationalBureauofStandards,AppliedMathematicsSeries-55
3) J. Sinha Roy and S. Padhy, Ordinary and Partial Differential Equation, Kalyani Publisher.
4) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of the effective mathematical tools for the solutions of differential equations that models various physical processes.
CO2	Describe power series solution of differential equations
CO3	Demonstrate analytic functions and applications of Cauchy-Riemann equations.
CO4	Evaluate integration of complex valued functions, and apply Taylor and Laurent series expansions of functions in various fields of engineering problems.
CO5	Compute roots of algebraic and transcendental equations, and also evaluate the integrals by Trapezoidal and Simson's rules.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

Code: Subject: Chemistry Credits: 4[3-1-0] (BCH02001)

Module-I (9 Hours)

Schrodinger Wave equations (not to be derived), Application to particle in ID box. Molecular rotational (microwave) spectroscopy: Basic principle and application to diatomic molecules, selection rules.

Molecular vibrational (IR) spectroscopy: Basic principle, types of vibrations and vibrational frequency, application to Harmonic and anharmonic oscillators, selection rules, modes of vibration. Electronic (UV-Visible) spectroscopy: Basis principle, types of electronic transitions, The Franck-Condon principle, and Jablonski diagram.

Module-II (9 Hours)
Thermodynamics of Chemical Processes:

Concept of Entropy and free energy, Chemical Potential, Equilibrium Conditions.

Phase equilibria:

Phase, Components, Degree of Freedom, Phase Rule Equation. Phase Diagrams: One Component Systems – Water and Sulphur, Basic idea of (a) Peritectic system, (b) Eutectoid system, (c) Binary phase diagrams of Pb-Ag & Fe-C system.

Module-III (9 Hours)
Electrochemistry:

Electrode Potentials and its Relevance to Oxidation and Reduction, Types of electrodes, Galvanic cell, Measurement of EMF and application of EMF measurements, Types of reference electrodes (Hydrogen, Glass, Quinhydrone Electrodes,) Determination of pH, Electrochemical energy systems its types (Dry Cells, lead acid cell and Fuel Cells: Construction, reaction, advantages and applications).

Corrosion: Concept, types of corrosion, dry or chemical and wet or Galvanic/electrochemical Corrosion, Factors affecting corrosion.

Module-IV (9 Hours)

Kinetics of complex Chemical Reactions: Reversible, Consecutive and Parallel Reactions, Steady State Approximation, Chain reaction.

Module-V (9 Hours)

Chemistry of engineering materials:

Nanomaterials: Applications of nanomaterials. **Organometallics:** Application of organometallics

Books Recommended:
1) P.W. Atkins, Elements of Physical Chemistry,4th Edition, Oxford University Press
2) C.N. Banwell and E. M. MacCash, Fundamentals of Molecular Spectroscopy,5th Edition,

3) P.K. Kar, S.Dash and B.Mishra,B.Tech.ChemistryVol.I,Kalyani Publications

Course Outcomes:

CO1	Apply the basic concept of classical mechanics and quantum chemistry to real life applications & to understand the basic concept of electromagnetic radiation, spectroscopic techniques and their applications
CO2	Should perceive the spontaneity/feasibility of a process applying thermodynamics concepts and to keep up with the idea of phase equilibria, phase rule and its application to one and two component system.
CO3	Define the application of electrochemistry to commercial electrochemical cell and corrosion.
CO4	Able to apply the basic concept of kinetics of are action to complex reactions.
CO5	To demonstrate the properties and applications of organometallics and nanomaterials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	1	-	-	1	1	1
CO2	3	3	1	-	-	-	1	-	-	1	1	1
CO3	3	3	1	-	-	-	1	-	-	1	1	1
CO4	3	3	1	-	-	-	1	-	-	1	1	1
CO4	3	3	1	-	-	-	1	-	-	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	1	-	-	-	1	-	-	1	1	1

BASIC ELECTRONICS (BEC02001)

Module-I (12 Hours)

Introduction to Electronics: - Signals, Frequency Spectrum of Signals, Analog and Digital Signals, Linear Wave Shaping Circuits: - RC LPF, Integrator, RC HPF, Differentiator Properties of Semiconductors: - Intrinsic, Extrinsic Semiconductors, Current Flow in Semiconductors, Diodes: - p-n junction theory, Current-Voltage characteristics, Analysis of Diode circuits, Rectifiers, Clippers, Clampers, Special diodes- LED, Photo diode, Zener Diode

Module-II (10 Hours)

Bipolar junction Transistor (BJTs):- Device Structure and Operation, Current-Voltage Characteristics, BJT as an Amplifier and as a Switch. Introduction to Power Amplifiers: - A, B and C types. JFET:- Physical Structure, Operation and Characteristics.

Module-III (8 Hours)

Feedback Amplifiers: - General Feedback Structure, Properties of Negative Feedback, Four Basic Feedback Topologies (block diagram only), Practical feedback circuit. Operational Amplifiers (OP-AMPs): - The Ideal OP-AMP, Inverting Configuration, Non-Inverting Configuration. OP-AMP Applications (Adder, Subtractor, Integrator, Differentiator).

Module-IV (6 Hours)

Digital Fundamentals: -Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to-Decimal Conversion, Binary Addition, Subtraction, Multiplication and Division, Hexa decimal Number Systems, Logic Gates, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, RS Flip Flop

Module-V (6 Hours)

Introduction to Electronic Instruments: -CRO: CRT, Wave form Display, Applications of CRO, Electronic Multi meter, Audio Signal Generator: -Block diagram, Front Panel Controls. Principles of Communication: - Fundamentals of AM & FM, Block diagram of Transmitters

TEXT BOOK

1. Microelectronics Circuits, A.S Sedra, K.C. Smith, Oxford University Press. Selected portions from chapters 1to 3,5,8,13.
2. Electronics Fundamentals and Applications, D Chattopadhyay and P.C. Rakshit, New Age International Publications. Selected portions fromchapters4to12,14,16to18,20,21.

REFERENCEBOOK

1. Integrated Electronics, Millman and Halkias, TMH Publications.
2. Electronic Devices & Circuit Theory, R. L Boylestad and L.Nashelsky, Pearson Education.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement different types of signals and its application to semiconductor devices and circuits.
CO2	Analyze the concept of different BJTs and its operation.
CO3	Express the concept of the Feedback Amplifiers and Operational Amplifiers.
CO4	Apply fundamentals of different Digital arithmetic operations and Digital circuits.
CO5	Demonstrate basic principles of important Electronic Instruments and Communication systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	2	-	-	-	-	1
CO2	3	2	2	3	2	1	1	-	-	-	-	1
CO3	3	2	3	3	2	1	2	-	-	-	-	1
CO4	3	3	3	3	3	1	1	-	-	-	-	1
CO5	3	3	3	3	2	1	3	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	**3**	**2**	**3**	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**1**

PROGRAMMING FOR PROBLEM SOLVING (BIT 02001)

Module -I (8 Hours)

Introduction to computing- Block architecture of a computer, fundamental units of storage: bit, bytes, nibbles, word size. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flowcharts. Level of programming Languages, structure of C program, Compiling and Executing C program

Module-II (8 Hours)

C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input &Output - Input & Output Assignments, Formatted Outputs. Operators and Expressions-Operators, Precedence of operators. Decision Control Structure, Loop Control Structure and Case Control Structure.

Module-III (8 Hours)

Functions: Monolithic vs Modular programs, User defined vs standard functions, formal vs Actual arguments, Functions category, function prototypes, parameter passing, Recursion.Arrays1D Array,2D Array &Multi-Dimensional Array. Strings- Declaration& Initialization, String Handling Functions.

Module-IV (8 Hours)

Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function. Dynamic Memory Allocation. Structure, Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, Union, Array of Union Variables, Union inside Structure, Bit Fields. Storage Class.

Module-V (8 Hours)

Preprocessor Directives- Types, Pragma Directives, Conditional Directives. Type def, Enumerated Data Type. Files- Reading data from Files, reading data from Files, Writing data to Files, Error Handling during File Operations. Advanced Issues in Input &Output – using argc&argv.

Text Books:

1. Programming in ANSIC, E Balaguruswamy
2. Computer Fundamentals & Programming in C: Reema Thareja, Oxford University Press.

Reference Books:

1. Let us C-Y.Kanetkar, BPB Publications.
2. Programming with ANSI and Turbo C-Kamthane,A.N.Pearson Education
3. C How to Program-Deitel and Deitel, Pearson Education.
4. The C Programming Language-BrianW.Kernighan and DennisM.Ritchie,Prentice Hall.

Course Outcomes:
Upon completion of the subject the students will demonstrate the ability to:

CO1	Grasp the fundamentals of Computer and problem solving
CO2	Conceptualize fundamentals of C Programming along with control structures.
CO3	Implement different problems on functions and arrays.
CO4	Apply pointers structures and unions for problem solving.
CO5	Gain knowledge of pre-processor directives and file operations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	2	-	-	3
CO2	3	3	3	3	2	-	-	-	2	-	-	3
CO3	3	3	3	3	2	-	-	-	2	-	-	3
CO4	3	3	3	3	2	-	-	-	2	-	-	3
CO5	3	3	3	3	2	-	-	-	2	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	-	-	-	2	-	-	3

Basic of Civil Engineering **BCE02001**

Module-I

Introduction to Civil Engineering – Various disciplines of Civil engineering, Importance of Civil engineering in infrastructure development of the country.

Introduction to types of buildings as per NBC, Selection of site for buildings, Components of a residential building and their functions, Introduction to Industrial buildings and types.

Building Planning – Basic requirements, elements, introduction to various building area terms, computation of plinth area, carpet area.

Module-II

Surveying – Principle and objectives, Instruments used, Horizontal measurements, Ranging (direct ranging only), Instruments used for ranging, Leveling – Definition, Principles, Instruments, Preparation of level book, problems on leveling, Modern surveying instruments – EDM, Total station, GPS (Brief discussion)

Building Materials – Bricks, properties and specifications, Cement – Types, properties, grades, other types of cement and uses, Cement mortar – Constituents, Preparation,Concrete– PCCandRCC,Grades,Steel–Useofsteelinbuildings,types.

Module-III

Building Construction – Foundations, Classification, Bearing Capacity of Soil and related terms (definition only), Masonry Works – classifications, definition of different technical terms, Brick masonry – types, bonds, general principle, Roofs – functional requirements, basic technical terms, roof covering material, Floors – function, types, flooring materials(brief discussion), Plastering and Painting – objectives, types, preparation and procedure of application.

Module-IV

Basic Infrastructure services — air conditioning & purpose, fire protection & materials, Ventilation, necessity & functional requirements, Lifts, Escalators.

Introduction to planning and design aspects of transportation engineering, Transportation modes, Highway engineering – historical development, highway planning, classification of highway, Railway Engineering — cross section of rail track, basic terminology, geometric design parameter(brief discussion only).

Module-V

Airport engineering–development, types, definition, characteristics of aircraft, basic terminology, Traffic engineering – traffic characteristics, traffic studies, traffic operations (signals, signs, markings), Urban engineering–classification of urban road.

Irrigation & Water Supply Engineering–Introduction, Types of Irrigation, different types of hydraulic structures, dam and weirs, types of dam, purpose and functions.

Text Books:

- Basic Civil engineering, Gopi, S., Pearson Publication
- Basic Civil Engineering, Bhavikatti, S. S., New Age.

Reference Books:

- Construction Technology, Chudley, R., Longman Group,England
- Basic Civil and Environmental Engineering, C.P. Kausik, NewAge.
- AmericanSocietyofCivilEngineers(2011)ASCECodeofEthics–PrinciplesStudyandApplication

Course Outcomes:

CO1	Analyze the fundamental aspect of building planning.
CO2	Summarize general aspect of building material and surveying.
CO3	Explain about building constructions.
CO4	Judge transportation modes and planning.
CO5	Describe about Airport & Irrigation Structures.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	1	1	-						
CO2	3	2	1	1	1							
CO3	2	1			3							
CO4	3	2	1	2	1	3						
CO5	3	2	3	2	1	1	3	1	2	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	2	1	2	3	1	2	2	2	3

B. Tech Chemistry Lab: **(BCH02002)**

List of Experiments to be done (Any ten Experiments)

1. Determination of amount of sodium hydroxide and sodium carbonate in a Mixture.
2. Determination of Total hardness of water by EDTA method.
3. Estimation of calcium present in the limestone.
4. Standardization of KMnO4 using sodium oxalate.
5. Determination of ferrous iron in Mohr's salt by potassium permanganate.
6. Determination of Rate constant of acid catalyzed hydrolysis of ester.
7. Determination of dissolved oxygen in a sample of water.
8. Conductometric titration of strong acid and strong base
9. Determination of Viscosity of lubricating oil by red wood Viscometer.
10. Determination of Flash point of given oil by Pen sky Marten's Flash Point Apparatus.
11. Determination of available chlorine in bleaching powder.
12. Preparation of acidic and basic buffer solution and measurement of PH using PH meter

Book Recommended:

B. Tech Practical Chemistry-.

Course Outcomes:

CO1	Develop knowledge of concepts and applications of chemistry, important laboratory analytical techniques, and instrumentation.
CO2	Apply fundamental principles for environmental analytical methods.
CO3	Identify suitable analytical techniques for analysing a specific compound in a sample and ensure quality control.
CO4	Implement suitable techniques for sampling and handling of environmental and chemical samples.
CO5	Hands on training on using different laboratory apparatus and equipments including data analysis and conclusions.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	-	1	-	2	-	1	-	1	-
CO2	3	1	2	-	1	-	2	-	1	-	1	-
CO3	3	1	2	-	1	-	2	-	1	-	1	-
CO4	3	1	2	-	1	-	2	-	1	-	1	-
CO4	3	1	2	-	1	-	2	-	1	-	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1-	PO11	PO12
CO	3	1	2	-	1	-	2	-	1	-	1	-

BASIC ELECTRONICS LAB (BEC02002)

Experiments

1. Familiarity with electronic components and devices(Testing of semiconductor diode, Transistor, IC Pins connection) Digital Multimeter should be used.
2. Study and use of CRO to view waveforms and measure its Amplitude and Frequency.
3. Frequency response of LPF and HPF.
4. V-I Characteristics of a Semiconductor Diode. Determining DC and AC resistance.
5. Clipper Circuit.
6. Clamper Circuit.
7. Half Wave and Full Wave Rectifier without Capacitor filter. Record of Waveforms, Measurement of Average and RMS value.
8. V-I (Output)Characteristics of N-P-N/P-N-P Transistor in CE Configuration.
9. OP-AMP: Inverting and Non-Inverting Configuration. Record of Waveforms.
10. Verification of Truth table of Logicgates (AND,OR,NOT,NAND,NOR,EX-OR)

Supplementary book

1. Integrated Electronics, Millman and Halkias, TMH Publications.
Electronic Devices & Circuit Theory, R.LBoylestad and L.Nashelsky, Pearson Education**Course Outcomes:**

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement Acquire basic knowledge on electronic devices and components
CO2	Analyze different electronics circuits using semiconductor diodes.
CO3	Analyze and develop the characteristics of BJT and FET Circuits.
CO4	Apply fundamentals Operation al amplifier circuits.
CO5	Implement knowledge on basic digital logic gates

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	2	-	-	-	-	1
CO2	3	2	2	3	2	1	1	-	-	-	-	1
CO3	3	2	3	3	2	1	2	-	-	-	-	1
CO4	3	3	3	3	3	1	1	-	-	-	-	1
CO5	3	3	3	3	2	1	3	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	3	2	1	2	-	-	-	-	1

PROGRAMMING FOR PROBLEM SOLVING LAB (BIT02002)

L-T-P:0-0-3 Cr.-1.5

Topics to be covered:

1. Programs using Input–Output functions.
2. Programs on variable declaration, assignments, operators and typecasting.
3. Program on selection& iterative constructs.
4. Programs on functions.
5. Programs on arrays.
6. Programs on string manipulation.
7. Programs on pointers.
8. Programs on structure &union.
9. Programs on file handling.
10. A mini-project to be designed by students using features of C.

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement the basics of C programming.
CO2	Exercise conditional and iterative statements to develop programs.
CO3	Exercise user defined functions to solve real time problems.
CO4	Demonstrate the concept of pointers to access arrays, strings and functions.
CO5	Create C programs on file manipulations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	2	3	-	-	3
CO2	3	3	3	3	2	-	-	2	3	-	-	3
CO3	3	3	3	3	2	-	-	2	3	-	-	3
CO4	3	3	3	3	2	-	-	2	3	-	-	3
CO5	3	3	3	3	2	-	-	2	3	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-:No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	-	-	2	3	-	-	3

Engineering Graphics & Design **(BCE02002)**

Module-I

Introduction to Engineering Drawing: Drawing instruments, lines, lettering and dimensioning. Scales: Plain, Diagonal and Vernier Scales.

Module-II

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

Module-III

Orthographic Projections: Concepts, Orthographic projections of points, Lines, Planes and Solids. Sections of solids; Development of surfaces

Module-IV

Isometric Projections: Principles, Isometric Scale, Isometric Views, Isometric Views of lines, Planes, Simple and compound Solids.

Module-V

Introduction to Auto-Cad:
Curves:Parabola,Ellipse,Hyperbola,Cycloid,Epicycloid,Hypocycloidand Involute

Reference Books:

1 Engineering drawing by N.D. Bhatt andV. M Panchal, Charotar Publishing House, Anand.
Engineering Drawing by Venugopal, New Agepublisher.

Course Outcomes:

CO1	Revise basics of engineering drawings and curves.
CO2	Use Orthographic projections of Lines, Planes, and Solids.
CO3	Apply Sectioning of various Solids and their representation.
CO4	Change Pictorial views to Orthographic Projections
CO5	Construct Isometric Scale, Isometric Projections and Views.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	1	1							
CO2	3	2	1	1	1							
CO3	2	1			2							
CO4	3	2	1	2	1	1						
CO5	3	2	2	2	1	1	3	1	2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	2	1	1	3	1	2	2	2	2

3rd Semester

MATHEMATICS-III (BMA03001)

(Transforms, Probability and Statistics and Multivariate Analysis) [3-1-0]

Module-I: Laplace Transforms (10 Hours)

Laplace transforms, inverse transforms, linearity, shifting, transforms of derivatives and integrals, solution of ODEs, unit step function, Dirac's delta function, differentiation and integration of transforms, convolution, integral equations.

Module-II: Fourier Transforms (8 Hours)

Basic concept of Fourier integral, Fourier sine and cosine integral, condition of convergence, Fourier transformation, Fourier sine transform, Fourier cosine transform, properties.

Module-III: Probability (6 Hours)

Random variables, probability distributions, mean and variance, Binomial, Poisson and hyper-geometric distributions, Normal distribution.

Module-IV: Statistics (8 Hours)

Random sampling, point estimation of parameters, maximum likelihood estimation, confidence intervals, testing of hypotheses for mean and variance, correlation and regression.

Module-V: Multi-variate Analysis (8 Hours)

Line integrals, double integrals, change of order, Green's theorem (statements only), surface integrals, triple integrals, Divergence theorem of Gauss (statements only), Stoke's theorem (statements only) and applications.

Text Book: Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition

Reference Books:

1) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
2) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of Laplace and Fourier transforms, and apply this idea to solve differential equations.
CO2	Describe unit step function and Dirac's delta function which are useful in engineering problems.
CO3	Apply Binomial, Poisson and Normal distributions in probabilistic models.
CO4	Demonstrate random sampling and estimation of parameters.
CO5	Evaluate multiple integrals and with various applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

Course	3	3	2	2	1	2	1	-	-	-	1	1

FLUID MECHANICS (Code: BCM 03001)

Module-I (8 Hours)

Units and dimensional analysis, Types of Fluids. Fluid Statics: Hydrostatic Pressure, Pressure measuring Devices.

Module-II (8 Hours)

Introduction to fluids in motion, Flow in boundary layers. Its formation & growth in tubes & plates. Basic equations of fluid flow continuity, momentum & Bernoulli's equation. Flow measuring devices: Venturi, Orifice, Pitot tube, and Rotameter.

Module-III (8 Hours)

Flow of incompressible fluid in pipes, Relation between skin friction & wall shear. Laminar flow in pipes, Hagen–Poiseuille equation, Friction factor, Friction from changes in velocity or direction, Flow of compressible fluids, Basic equations. Flow past immersed bodies, Drag Coefficient. Motion of particles through fluids. Its mechanics, Terminal velocity.

Module-IV (8 Hours)

Friction inflow through beds of solids, Fluidization, Mechanism of fluidization, pressure drop in fluidization, Applications of fluidization.

Module-V (8 Hours)

Transportation of fluids, reciprocating, rotary & centrifugal pump, fans, blowers & compressors. Characteristics curves & calculation of power & efficiency of pumps. Concept of slip.

Text Books:

1. Unit Operations of Chemical Engineering, 7th ed. by W L McCabe, J C Smith, and P. Harriott, McGraw-Hill.
2. Fluid Mechanics for Chemical Engineers, 3rd ed. by Noel de Nevers, McGraw-Hill.

Reference Books:

1. A Textbook of Fluid Mechanics and Hydraulic Machines, 9th ed. by R K Bansal.
2. Fluid Mechanics: Including Hydraulic Machines by A K Jain.
3. Introduction to Fluid Mechanics and Fluid Machines, 3rd ed. by S K Som, G Biswas, and S. Chakraborty, McGraw-Hill, 2011.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge of differential equations of fluid mechanics including the ability to apply and understand the impact of assumptions made in the analysis.
CO2	Apply the concepts of boundary layer and its estimation in different flows
CO3	Describe the compressible flow equations and multiphase flow correlations.
CO4	Describe the dynamics of drops and bubbles quantitatively.
CO5	Describe fluid flow problems with the application of the momentum and energy equations

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

CHEMICAL PROCESS CALCULATION (Code: BCM 03002)

Module-I (8 Hours)

Units and dimensions, composition of solids, liquids and gases, excess and limiting reactant, conversion, yield, Ideal gas equation, mixtures of ideal gases.

Module-II (8 Hours)

Real gases, equations of state, vapor pressure and boiling point, Clapeyron equation, ClausiusClapeyron equation, Antoine equation, vapor pressure plot, Ideal solutions and Raoult's law.

Module-III (8 Hours)

Material balance calculations for unit operations like mixing, evaporation, crystallization, distillation, bypass, recycle and purging.

Module-IV (8 Hours)

Internal energy, enthalpy, heat capacities, mean heat capacity, heat capacity of mixtures of gases, heat capacity of solids and liquids, heat of fusion, heat of vaporisation, Clapeyron equation, Trouton's rule, Kistyakowsky equation, standard heat of reaction, combustion, and formation, Hess's law of constant heat summation.

Module-V (8 Hours)

Effect of temperature on heat of reaction, temperature of reaction, adiabatic reaction temperature, adiabatic flame temperature, theoretical flame temperature.

Text Books:

1. Stoichiometry and process calculations, K.V. Narayanan, B. Lakshmikutty, PHI
2. Chemical process principles, Part 1, O.A. Hougen, K.M. Watson, R.A. Ragatz, CBS pub.
3. Elementary principles of chemical processes, Richard M. Felder, Ronald W.Rousseau, John Wiley & sons

Reference Books:

1. Stoichiometry, B.I. Bhatt, S.M. Vora, MGH
2. Basic principles and calculations in chemical engineering, David M. Himmelblau, Pearson education pvt. ltd.
3. Chemical reactions and stoichiometry, R.K. Dave, Campus book international
4. Problems in stoichiometry, M. Sylvin, Sarup& sons.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge of material balances on unit operations and processes.
CO2	Apply the knowledge to perform energy balances.
CO3	Describes input and output streams on flow charts.
CO4	Apply the knowledge to solve bypass, recycle and purging operation problems.
CO5	Describes heat of reaction, endothermic and exothermic reactions, heat of formation, heat of combustion and heating value of a fuel.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	1	1	-	-	1	1
CO2	3	3	2	1	2	1	1	1	-	-	1	1
CO3	3	3	2	1	2	1	1	1	-	-	1	1
CO4	3	3	2	1	2	1	1	1	-	-	1	1
CO5	3	3	2	1	2	1	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	1	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

COAL PROCESSING TECHNOLOGY (Code: BCM 03003)

Module-I (8 Hours)

Clean coal technology, Coal processing, Screening of coal, Size reduction of coal, Pulp/Slurry density, Wash ability of coal

Module-II (8 Hours)

Coal beneficiation processes, Principles of gravity concentration processes, Heavy medium separation, Jigging, Flowing film concentration, Cyclone separation, Froth flotation, Centrifugal separators

Module-III (8 Hours)

Dry beneficiation of coal, Dewatering, Coal washing efficiency, Coal washing practice in India, Recent development in coal processing

Module-IV (8 Hours)

Coal utilization, Carbonization, Coking mechanism, Selection of coal for metallurgical coke, Combustion

Module-V (8 Hours)

Gasification, Types of gasifiers, liquefaction, production of liquid fuels, carbon capture and storage

Text Books:

1. Coal processing and utilization, D. V. SubbaRao, T. Gouricharan, CRC Press
2. Elements of fuel, combustion and energy, S. N. Saha, DhanpatRai publishing company (P) ltd.
3. Elements of fuels, furnaces and refractories, O. P. Gupta, Khanna pub.

Reference Books:

1. Coal, coke and coal chemicals, Wilson & Wales, MGH
2. Liquefaction and gasification of coal, Mangold
3. Fuels and combustion, Samir Sarkar, Universities press

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Describe the different coal preparation methods.
CO2	Describe the different mechanical unit operations related to coal processing.
CO3	Apply the knowledge of coal washing.
CO4	Describe the different flow sheets for coal processing.
CO5	Apply the knowledge of recent coal utilization methods.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	1	1	2	1	1	1	1
CO2	3	2	3	1	2	1	1	2	1	1	1	1
CO3	3	2	3	1	2	1	1	2	1	1	1	1
CO4	3	2	3	1	2	1	1	2	1	1	1	1
CO5	3	2	3	1	2	1	1	2	1	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	1	2	1	1	2	1	1	1	1

ECONOMICS FOR ENGINEERS (3-0-0) (BHU03001)

Module-I

Theory of Demand: Demand and Utility, Demand function and the factors determining demand, Law of Demand, Reasons for downward sloping demand curve, Exceptions to the law of demand. The market forces of Supply and Demand, Elasticity of demand and its application, Utility analysis: cardinal and ordinal measurability of utility, Assumptions of cardinal utility analysis, law of diminishing marginal utility, Consumer's equilibrium: Principle of equi-marginal utility

Module-II

Indifference curve analysis of demand: Concepts, properties, Equilibrium of the consumer, Price Consumption Curve (PCC) and Income Consumption Curve, Decomposition of price Effect into income effect and substitution effect, Revealed preference hypothesis, Individual Choice under Risk and Uncertainty: St. Petersburg paradox and Bernoulli's hypothesis, Neumann- Morgenstern method of constructing utility index, Friedman-Savage hypothesis, Markowitz Hypothesis.

Module-III

Production function: short run analysis, Total product, Average product and Marginal product, output elasticity of input, law of variable proportion, Long run production function: Isoquants and concepts of returns to scale, Optimum factor combinations, Homogeneous Production Function, Cobb–Douglas production function, CES Production function, Cost Analysis: Concepts, Accounting cost, Fixed and variable cost, opportunity cost, Short run and long run cost curves, Relationships between average cost and marginal cost

Module-IV

Market and its classifications, Perfect competition: Characteristics, Short run and long run equilibrium of firm under perfect competition. Monopoly market: Price and output determination. Modern theories of firms: Baumol's theory of sales revenue maximisation, Bain'slimitpricing model

Module-V

Time value of money: use of cash flow diagram, Annual economic worth, present worth, future worth, Internal Rate of Return (IRR), Net Present Value (NPV), Payback period method, Analysis of public projects: Cost-Benefit analysis, cost effectiveness

Reference Books:

1. Koutsoyiannis,A.(1979). ModernMicroeconomics.The MacmillanPressLtd.,London
2. Varian,H.R.(1992).IntroductiontoMicroEconomicAnalysis,Nortonandcompany,NewYork
3. Salvatore,D.(2008).Microeconomics:theoryandapplications.OxfordUniversityPress
4. Pindyck, R. S., D. N. Rubinfeld and P. L. Meheta (2009). Microeconomics, Pearson India, NewDelhi
5. Panneerselvam,R.(2007).EngineeringEconomics,Prentice-HallofIndia,NewDelhi
6. Henderson,J.M.andR.E.Quant(2011).MicroeconomicTheory:AMathematicalApproach, Indian Higher Education, New Delhi
7. Intriligator,M.D.,R.G.BodkinandC.Hsiao(1995).EconometricModels,Techniques,andApplications,Pearson India, New Delhi

Course Outcomes:

Upon completion of the subject the student will be able to:

CO1	Utilise economics principles in consumption process
CO2	Describe the utility measurement and measure the utility associated with risk
CO3	Efficient use of resources in production and take decision regarding optimum output
CO4	Describe market me chanism and analyse product market to take proper decisions
CO5	Implement economic principles in company related decision making

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	2	-	-	-	3	3
CO2	-	-	-	-	-	3	2	2	-	-	2	1
CO3	-	-	-	-	-	3	3	-	-	-	3	-
CO4	-	-	-	-	-	2	2	1	1	1	3	-
CO5	-	-	-	-	-	1	2	1	2	-	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)-: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	-	-	-	3	2	1	1	1	3	2

SESSIONAL

FUEL TECHNOLOGY-I LABORATORY (Code: BCM03004)

List of experiments:

1. To determine the composition of the supplied sample of Coal by Proximate Analysis
2. To determination of Caking Index of the supplied sample of Coal
3. To determine the wash ability characteristics of the supplied sample of Coal
4. To determine the ultimate analysis of the supplied sample of coal
5. To determine the Swelling Index of the supplied sample of coal
6. To ascertain the agglomerating characteristics of the coal sample.
7. To determine the Gross calorific value of the supplied sample of coal using Bomb Calorimeter.
8. To determine the Gross calorific value of the supplied sample of coal using Automatic Bomb Calorimeter.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Analyse the composition of supplied coal samples by proximate Analysis.
CO2	Analyse the elemental composition of supplied coal samples by Ultimate Analysis.
CO3	Demonstrate the knowledge of swelling index and wash ability of supplied coal samples.
CO4	Apply the knowledge of agglomerating characteristics of the coal sample.
CO5	Demonstrate the working principle of Bomb calorimeter.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	3	1	3	2	1	1	-	2	3
CO2	2	1	-	3	1	3	2	1	1	-	2	3
CO3	2	1	-	3	1	3	2	1	1	-	2	3
CO4	2	1	-	3	1	3	2	1	1	-	2	3
CO5	2	1	-	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	1	-	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

FLUID MECHANICS- I LABORATORY (Code: BCM03005)

List of experiments:

1. Manometers –To find the pressure drop for flow through pipes.
2. Fluidized bed – To determine minimum fluidization velocity and pressure drop
3. Venturi meter– To find out the flow rate of fluid flowing inside a pipe.
4. Reynold's Apparatus – To verify the flow whether it is laminar or turbulent.
5. Bernoulli's Apparatus – To verify Bernoulli's equation.
6. To measure the flow rate of a fluid by using V – Notch.
7. To measure the flow rate of a fluid by using rectangular Notch.
8. Orifice Meter -To find out the flow rate of fluid flowing inside a pipe.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge of Bernoulli's theorem.
CO2	Demonstrate the working of different notches.
CO3	Demonstrate the working of orifice meter and venturi meter..
CO4	Apply the knowledge of pressure drop and minimum fluidisation velocity.
CO5	Demonstrate the working principle of Reynolds apparatus..

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PROCESS TECHNOLOGY LABORATORY (Code: BCM03006)

List of experiments:

1. To prepare soap and determination of the alkali content of soap.
2. To determine the saponification value and bromine value of the oil.
3. To determine the fat content of food stuff.
4. To find the total organic carbon of the water sample.
5. To find out the distribution coefficient of iodine in organic solvent and water.
6. To determine the iron content of a given salt solution.
7. To determine the lime content of the Portland cement.
8. To determine the dye concentration using a spectrophotometer.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Explain the importance of alkali content, saponification value, bromine value, fat content of organic material
CO2	Evaluate the alkali content of soap, saponification value and bromine value of the oil, fat content of food stuff
CO3	Evaluate the total organic carbon of the water sample, the distribution coefficient of iodine in organic solvent and water.
CO4	Evaluate the iron content of a given salt solution and lime content of the Portland cement.
CO5	Perform experiments using spectrophotometer and analyse the data.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	3	1	3	2	1	1	-	2	3
CO2	2	1	-	3	1	3	2	1	1	-	2	3
CO3	2	1	-	3	1	3	2	1	1	-	2	3
CO4	2	1	-	3	1	3	2	1	1	-	2	3
CO5	2	1	-	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	1	-	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

ENVIRONMENTAL ENGINEERING LABORATORY (Code: BCM03007)

List of experiments

1. To determine the pH value of given water samples
2. To determine turbidity of given water samples
3. To determine the colour of given water samples
4. To determine the hardness of a given samples by soap solution method
5. To determine the acidity of given water samples
6. To determine the residual chlorine of given water samples
7. To determine the total solid of given samples
8. To determine the odour of given water samples
9. To determine chloride content of given water samples
10. To determine the BOD of given water samples.
11. To determine the COD of given water samples.

Course Outcomes: Upon completion of the subject the students will be able to

CO1	Discuss the importance of water and its quality analysis.
CO2	Estimate the quality of drinking water and domestic wastewater generated
CO3	Analyse various physico-chemical parameters of water in case of quality requirements.
CO4	Analyse various biological parameters of water in case of quality requirements.
CO5	Suggest various types of treatment methods required to purify raw or waste water with different contaminants.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	3	-	2	2	2	1	-	3	2
CO2	3	2	-	3	-	2	2	2	1	-	3	2
CO3	3	2	-	3	-	2	2	2	1	-	3	2
CO4	3	2	-	3	-	2	2	2	1	-	3	2
CO5	3	2	-	3	-	2	2	2	1	-	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	2	-	3	-	2	2	2	1	-	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

4TH SEMESTER

MATHEMATICS-IV (Numerical Methods) (BMA04001)

Module-I: Errors and Root Extraction (8 Hours)
Definition and sources of error, Propagation of errors, finding roots of algebraic and transcendental equations by Bisection method, Newton's method, Secant method, fixed point iteration method.

Module-II: Interpolation (8 Hours)
Interpolation, Lagrange's interpolation, Newton's divided differences, Forward differences, Backward differences, Central differences, Interpolation error.

Module-III: Numerical integration (8 Hours)
Numerical integration: Newton-Cotes Integration formula (without derivation), Trapezoidalule, Simpson's rule, Gaussian quadrature, Errors in Numerical Integration.

Module-IV: Numerical Solution of Differential Equations (8 Hours)
Solution of ODE's: Euler's method, Improved Euler's method, Runge-Kutta Methods of order-2 & 4.

Module-V: Numerical Solution of system of linear equations (8 Hours)
Numerical Solution of system of linear equations, Gauss Elimination method, LU decomposition, Gauss-Jordan Elimination method, Gauss Jacobi and Gauss-seidal iteration methods

Text Books:

1. An introduction to numerical analysis, Jain, Iyengar and Jain, New Age International
2. Numerical Analysis, B.S. Grewal, Khanna Publishers

Course Outcomes:
Upon completion of the subject the students will be able to:

CO1	Compile roots of algebraic and transcendental equations
CO2	Incorporate interpolating polynomial for a given set of data
CO3	Apply numerical integration methods for computing definite integrals
CO4	Describe the solution of ordinary differential equations (IVP) by using numerical methods
CO5	Demonstrate approximate solutions for system of linear equations

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2:Moderate (Medium) 3:Substantial (High) -:No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

FUELS AND COMBUSTION (Code: BCM04001)

Module-I (6 Hours)

Solid fuels: Coal origin, Chemical composition, Calorific value, Classifications, Characteristic sand Distribution of Indian coals.

Module-II (8 Hours)

Storage and spontaneous combustion of coal, Coal washing and blending, Petrographic constituents of coal, Carbonization of coal, Manufacture and properties of metallurgical coke, Recovery of by products

Module-III (8 Hours)

Liquid fuels: Origin and composition of crude oil, Crude oil distillation and its products with special reference to gasoline, kerosene and diesel oil, Cracking and reforming, Shale oil, Fischer-Tropsch synthesis

Module-IV (8 Hours)

Gaseous fuels: Natural gas, Coal gas, Coke oven and blast furnace gas, Manufacture of water gas and producer gas, Carburetted water gas Synthetic fuels: Hydrogenation of coal

Module-V (10 Hours)

Combustion: Combustion of solid, liquid and gaseous fuels, combustion stoichiometry and thermodynamics, Calculation of volumes and weights of air required for combustion, the gas analysis

Text Books:

1. S. Sarkar, Fuels and Combustion, Univ press,3rdEdn.
2. S.N. Saha, Fuel Combustion Energy Technology, DhanpatRai pub. Co.
3. Elements of Fuels, furnaces and Refractories, O. P. Gupta, Khanna Publishers

Reference Books:

1. Himus, Elements of Fuel Technology

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge of basics of solid, liquid and gaseous fuels.
CO2	Describe the different characterization techniques of fuels.
CO3	Describe the different conversion techniques of fuels.
CO4	Describe the combustion process of fuels.
CO5	Apply the knowledge to calculate calorific values of different fuels.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	1	1	-	-	1	1
CO2	3	3	2	1	2	1	1	1	-	-	1	1
CO3	3	3	2	1	2	1	1	1	-	-	1	1
CO4	3	3	2	1	2	1	1	1	-	-	1	1
CO5	3	3	2	1	2	1	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	1	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

MECHANICAL OPERATIONS (Code: BCM04002)

Module-I (8 Hours)

Properties and storage of solids: Characteristics of solid particles and solids in bulk. Size Reduction: Objectives, Methods, and Principles of size reduction, Size reduction equipment: Coarse, Intermediate, and Fine Crushers and Ultra-fine grinders, Open & closed circuit grinding.

Module-II (8 Hours)

Solid-solid separation: Screening, Electrical separation, Classification, Gravity concentration, and Floatation and their latest equipment.

Module-III (8 Hours)

Solid-liquid separation: Sedimentation and equipment (Thickeners and clarifiers), Filtration: Theory and equipment.

Module-IV (8 Hours)

Gas-solid separation: Principle and equipment. Transportation of solids: Conveyors and elevators.

Module-V (8 Hours)

Mixing: Theory of solid and liquid mixing and their equipment. Size enlargement, Crystallization, Feeding, Weighing, and Coagulation.

Text Books:

1. C. M. Narayanan & B. C. Bhattacharyya, Mechanical Operation for Chemical Engineers, Khanna Publisher, Third Edition,2005.
2. W I McCabe & J C Smith, P. Harriot, Unit Operations of Chemical Engineering, McGraw Hill publication,2005.

Reference Books:

1. M. C. Fuerstenau and K. N. Han, Principles of Mineral Processing, John Wiley, N. Y, 2003.
2. J. F. Richardson, J. H. Harker & J. Backhurst, Chemical Engineering Volume II, Butterworth-Heinemann,1st Edn, 2002.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge for storage and handling of solid particle
CO2	Apply the knowledge to select suitable size reduction equipment
CO3	Describe different industrial screening equipment

CO4	Describe about different unit operations i.e solid-solid, solid-liquid & gas-solid separations
CO5	Describe different conveyors and transportation devices for handling of materials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

CHEMICAL ENGINEERING THERMODYNAMICS (Code: BCM04003)

Module-I (8 Hours)

Basic concepts: Thermodynamics system and surroundings, types of systems, Thermodynamic equilibrium and Phase Rule, Zeroth law of thermodynamics, State and Path dependent thermodynamic variables, Reversible and Irreversible Thermodynamic Process, Concept of Ideal gas**,** Properties of pure fluids; P-V-T behaviour of pure substances, Virial equations of state, The Ideal gas, Applications of Virial equations, Cubic equation of state, Theorem of corresponding states. Heat Effects of Phase Change.

Module-II (9 Hours)

The first law of Thermodynamics, Concept of Internal Energy and Enthalpy, Application of First law to Open Systems, Constant volume and Constant pressure process, Heat Engine and Second Law. Statements: Carnot Heat engine cycle and Second Law, Concept of Entropy, work function, Introduction to third law

Module-III (9 Hours)

Criteria of phase equilibrium, Ideal solutions (use of Raoult's law), Generation of P-x-y and T-x-y diagram for ideal solution, Non – ideal behavior, Partial Molar properties, Partial properties of Binary solution, Gibbs – Duhem equation, Concept of Fugacity and fugacity coefficient, calculation of fugacity Co-efficient using generalized correlation, excess Gibbs energy, Lewis – Randall Rule, Activity coefficient for VLE data

Module-IV (5 Hours)

Solution thermodynamics – thermodynamic properties and VLE from equation of state, Concept of Chemical Potential, Concept of Excess Properties and Residual Properties, properties of fluid mixtures using Redlich – Kwong equation of states.

Module-V (9 Hours)

Chemical reaction equilibria: Introduction, Reaction Coordinate, criteria to chemical reactions, Gibbs energy change, equilibrium constant of reaction, effect of temperature, calculation for single reaction in homogeneous and heterogeneous system

Text Books:

1. J. M. Smith, H. C. V. Ness and M. M. Abbot, Introduction to Chemical Engineering Thermodynamics, McGraw and Hills Publication, 2005

Reference Books:

1. K. Denbigh, The principles of Chemical equilibria with applications in Chemistry and Chemical Engineering, 1981
2. K.V. Narayanan, A Textbook of Chemical Engineering Thermodynamics, second edition, PHI Learning private limited, 2013

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge of contemporary issues related to chemical engineering thermodynamics.
CO2	Apply the knowledge of phase equilibria in two-component and multi-component systems.
CO3	Describe the thermodynamic properties of substances in gas or liquid state of ideal and real mixture.
CO4	Describe intermolecular potential and excess property behaviour of multi-component systems.
CO5	Apply the fundamental concepts of thermodynamics to engineering applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	-	-	1	1
CO2	3	3	2	1	3	2	1	1	-	-	1	1
CO3	3	3	2	1	3	2	1	1	-	-	1	1
CO4	3	3	2	1	3	2	1	1	-	-	1	1
CO5	3	3	2	1	3	2	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	1	2	1	1	2	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

ORGANIZATIONAL BEHAVIOUR Credit- 3-0-0 (BHU03001)

Module-I (6 Hours)

Fundamentals of OB: Learning objectives, Definition, scope and importance of OB, why to study OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), Behavioristic and social cognitive, Models of OB, New Challenges of OB Manager, Limitations of OB Learning: Nature of learning, Determinant of learning, how learning occurs, Learning and OB Case Study Analysis

Module –II (6 Hours)

Personality: Definition and importance of personality for performance, Nature and Determinants of personality, Theories of Personality, Personality Traits, Personality and OB Perception: Meaning and concept of perception, Perceptual process, Importance of perception in OB Motivation: Definition & Concept of Motive & Motivation, Theories of Motivation Herzberg ‘s Two Factor model Theory, Maslow ‘s Need Hierarchy, Aldefer‘s ERG theory) Case Study Analysis

Module-III (6 Hours)

Communication: Importance, The Communication Process, Types of communication, Barriers to communication, Communication networks, making communication effective Groups in organization: Nature, Types of Groups, Why do people join groups? Stages of Group Development, Group cohesiveness, Group decision making and managerial implication, Developing Work Teams, Team Building, Effective team building Leadership: Concept ofles of Leadership, Theories of leadership(Trait theory, Behavioral theory, Contingency theory), How to be an effective leader, Success stories of today‘s Global and Indian leaders. Case Study Analysis

Module-IV (6 Hours)

Conflict: Nature of conflict, Sources of Conflict, Conflict resolutions, Stages of conflict episode, Conflict management technique, Transactional Analysis (TA): Meaning of TA, Ego states, Types of transactions, Life position Case Study Analysis

Module-V (6 Hours)

Organizational Organizational Change: Why organizational change? Types of Organizational Change, Planned change, Kurt Lewin‘s-Three step model, Resistance to Change, Managing resistance to change. Organizational Culture: Meaning & definition, Types of culture, creating, sustaining and changing a culture, Concept of workplace spirituality. International OB: Introduction to International business, Individual and group behavior in International organization, How culture influence International OB? Case Study Analysis.

Reference Books:

1. Stephen P.Robbins, Organizational Behaviour, Printice Hall of India, New Delhi,2013
2. K. Aswathappa,Organizational Behaviour,HimalayaPublishingHouse,Bombay,2018
3. Nelson, D. L., and Quick, J. C. (2007)., Understanding Organizational Behaviour (3rded.)., Thompson South-Western Publication
4. Pareek, U. (2012), Understanding Organizational Behaviour (3rded.)., Oxford University Press.

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

CO1	Explain the transition process of management thought from traditional period to modern approaches.
CO2	Transfer the different motivational theories and evaluate motivational strategies used in a variety of organizational settings.
CO3	Identify and analyze the factors affecting individual and group behavior and evaluate the appropriateness of various leadership styles.
CO4	Evaluate the appropriateness of various conflict management strategies used in Organizations and develop strategies for re solving group conflict.
CO5	Explain how organizational change and culture affect working relationships within organizations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	2	2	1	1	3	2
CO2	-	-	-	-	-	1	1	1	3	1	-	
CO3	-	-	-	-	-	2	1	-	3	3	3	-
CO4	-	-	-	-	-	-	1	-	1	2	1	1
CO5	-	-	-	-	-	3	1	1	2	1	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	-	-	-	2	1	1	3	2	3	2

SESSIONAL

FUEL TECHNOLOGY-II LABORATORY (Code: BCM04004)

List of experiments:

1. To find the effect of temperature on viscosity of the supplied samples of liquid fuel using Redwood viscometer and Engler's viscometer.
2. To find the Flash and Fire point of the supplied samples of liquid fuel using Penskey Martein closed cup apparatus and Abel open cup apparatus.
3. To find the Aniline point of the supplied samples of liquid fuels.
4. To find the Carbon Residue of the supplied sample of lubricating oil using Conrads on apparatus.
5. To find the Pour point and cloud point of the supplied samples of liquid fuels.
6. To determine the Smoke Point of kerosene oil using Smoke Point Apparatus.
7. To determine the acid value of the supplied sample.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the working principle of Redwood viscometer and Engler's viscometer apparatus.
CO2	Demonstrate the working principle of PenskeyMartein closed cup apparatus and Abel open cup apparatus.
CO3	Apply the knowledge of different types of fuel properties of liquid fuels.
CO4	Demonstrate the working principle of Conradson Apparatus. .
CO5	Demonstrate the working principle of Smoke Point Apparatus.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	-	-	1	1
CO2	3	3	2	1	3	2	1	1	-	-	1	1
CO3	3	3	2	1	3	2	1	1	-	-	1	1
CO4	3	3	2	1	3	2	1	1	-	-	1	1
CO5	3	3	2	1	3	2	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	1	2	1	1	2	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

MECHANICAL OPERATION LABORATORY (Code: BCM04005)

List of experiments:

1. To find out the average size of particles in a sample (Volume-surface mean dia).
2. To determine the critical speed and time of grinding in a ball mill for producing a product with 80% passing a given screen.
3. To separate a mixture of coal into two fractions using froth flotation apparatus.
4. Determination of the effectiveness of a vibrating screen.
5. To study the characteristics of batch sedimentation using coal samples.
6. To determine the specific cake resistance and filter medium resistance of a slurry in Plate and frame filter press.
7. To separate a mixture of sand and iron powder by means of tabling.
8. To find out the reduction ratio in Jaw Crusher and Hammer Mill.
9. To find out the separation characteristics of Cyclone separators.
10. To study the operation of a magnetic separator and finding its efficiency.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the working principle of froth floatation apparatus.
CO2	Demonstrate the working principle of plate and frame filter press.
CO3	Apply the knowledge of different types of average diameter.
CO4	Demonstrate the working principle of cyclone separator.
CO5	Demonstrate the working principle of magnetic separator.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	1	1	3	3	2	1
CO2	3	3	2	2	3	2	1	1	3	3	2	1
CO3	3	3	2	2	3	2	1	1	3	3	2	1
CO4	3	3	2	2	3	2	1	1	3	3	2	1
CO5	3	3	2	2	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	3	2	1	1	3	3	2	1

FLUID MECHANICS-II LABORATORY (Code: BCM04006)

List of experiments:

1. To study the working principle of a reciprocating pump and to determine the percentage of slip
2. To study the working principle of a centrifugal pump and determine its efficiency
3. To find out the flow profile of water from hook's gauge
4. To determine coefficient of discharge using rectangular orifice
5. To determine coefficient of discharge using Triangular orifice
6. To measure pipe's friction for laminar and turbulent flow of fluid.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the working principle of reciprocating pumps.
CO2	Demonstrate the working principle of Hook's gauge.
CO3	Apply the knowledge of laminar and turbulent flow.
CO4	Demonstrate the working principle of centrifugal pumps.
CO5	Demonstrate the working principle of orifices.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	2	1
CO2	3	3	2	1	3	2	1	1	3	3	2	1
CO3	3	3	2	1	3	2	1	1	3	3	2	1
CO4	3	3	2	1	3	2	1	1	3	3	2	1
CO5	3	3	2	1	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	3	2	1	1	3	3	2	1

CHEMICAL ENGINEERING THERMODYNAMICS LABORATORY
(Code: BCM04007)

List of experiments:

1. To measure the specific latent heat of vaporization using an electric method.
2. To do the study experiment of a water to water heat pump.
3. To find out the C.O.P of the heat pump.
4. To find out the dryness fraction of steam using a separating calorimeter.
5. To find out the dryness fraction of steam using a separating calorimeter.
6. To do the study experiment of the air conditioner test rig.
7. To find out the C.O.P of the air conditioner test rig.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the working principle of a water to water heat pump apparatus.
CO2	Demonstrate the working principle of separating and throttling calorimeter apparatus.
CO3	Apply the knowledge to find out the efficiency and COP for the heat pump and refrigerator.
CO4	Demonstrate the working principle of the air conditioner test rig.
CO5	Apply the knowledge of COP for finding out the efficiency of test rig.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	3	2	1	1	-	-	1	1
CO2	3	3	2	1	3	2	1	1	-	-	1	1
CO3	3	3	2	1	3	2	1	1	-	-	1	1
CO4	3	3	2	1	3	2	1	1	-	-	1	1
CO5	3	3	2	1	3	2	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	3	1	2	1	1	2	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

5TH SEMESTER THEORY

HEAT TRANSFER (Code: BCM05001)

Module-I (8 Hours)

Introduction: Modes of heat transfer, basic laws of heat transfer, analogy between heat flow and electrical flow. Conduction: The Fourier heat conduction equation, Steady-state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces, unsteady state heat conduction through a semi-infinite slab, critical insulation of thickness of cylinder and sphere.

Module-II (8 Hours)

Convection: The convective heat transfer coefficient, introduction to thermal boundary layer, Dimensionless numbers in heat transfer and their significance. Dimensional analysis: forced Convection, Analogy between heat and momentum transfer: Reynold, Prandtl and Colburn Analogies. Heat transfer to liquid metals. Heat transfer for tubes in cross flow, Natural Convection: Grashoff number, Natural convection from vertical and horizontal surfaces.

Module-III (8 Hours)

Heat Exchanges: Types of heat exchangers, log mean temperature difference. Energy balances, Overall heat transfer Coefficients Heat Exchanger effectiveness. Fouling factors, Types of evaporators, capacity and economy of evaporators. Boiling point elevation and Duhring's rule Material and Energy evaporators, Methods of feeding, capacity and economy of multiple effect evaporators.

Module-IV (8 Hours)

Heat Transfer with phase change: Heat transfer from condensing vapours: film and drop wise Condensation. Derivation and practical use of the Nusselt equation. Condensation of superheated Vapours. Effect of non-condensable gases on ratio of condensation. Heat transfer to boiling liquids. Boiling of a saturated liquid. Maximum heat flux and critical temperature, minimum flux and film boiling, sub cooled boiling.

Module-V (8 Hours)

Heat transfer by radiation: Thermal radiation, Blackbody radiation, Kirchhoff's law, emissivity, grey body, laws of black body radiation, geometric factor, Radiation in enclosures with black surfaces and grey surfaces. Large parallel plates, concentric, cylindrical, spheres. Combined heat transfers by conduction, convection and radiation.

Text Books:

1. Unit Operations of Chemical Engineering, 7th ed. by W L McCabe, J C Smith, and P Harriott, McGraw-Hill.
2. D. Q. Kern, Process Heat Transfer, McGraw& Hills, 1982
3. F. P. Incropera, Fundamentals of Heat and Mass Transfer, John Wiley &Sons, 2007

Reference Books:

1. W. L. McCabe and J. C. Smith, Unit Operations of Chemical Engineering, McGraw& Hills, 2005.
2. R. W. Serth, Process Heat Transfer: Principle and Applications, Academic press, 2007.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply his knowledge on the conduction mode of heat transfer in different solid structures.
CO2	Analyze the convection mode of heat transfer for different cases with their analogies.
CO3	Understand the heat transfer mechanism in Heat exchangers and evaporators.
CO4	Apply his knowledge on condensation and boiling of liquids.
CO5	Understand the different laws and heat transfer mechanisms in radiation.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	-	-	1	1
CO2	3	3	2	1	3	2	1	1	-	-	1	1
CO3	3	3	2	1	3	2	1	1	-	-	1	1
CO4	3	3	2	1	3	2	1	1	-	-	1	1
CO5	3	3	2	1	3	2	1	1	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	1	2	1	1	2	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

MASS TRANSFER-I (Code: BCM05002)

Module-I (10 Hours)

Diffusion: Introduction to mass transfer operations. Molecular diffusion: concentration, velocity, frames of reference. Flux: Mass and Molar flux. Fick's Law of diffusion, Fundamental of eddy diffusion. Molecular diffusion in gases: Steady state molecular diffusion in binary mixture through a constant area, Non-equimolar counter diffusion of two components. Measurement of gas phase diffusion: Twin bulb method, Stefan tube method. Estimation of diffusivity in gases: Gilliland equation, Fuller et al. Equation, Chapman-Enskogequation. Molecular diffusion in liquids: Diffusion of component A through non-diffusing B, Equimolar counter-diffusion of A and B, Estimation of liquid diffusivity by Wilke-Chang equation. Experimental determination of liquid phase diffusivity. Diffusion phenomena: Knudsen diffusion, Surface diffusion and Self-diffusion.

Module-II (7 Hours)

Convective and Inter phase Mass Transfer: Mass transfer coefficient: Types of mass transfer coefficients, Diffusion of one component through the stagnant layer of another component, Equimolar counter-diffusion of two components, Volumetric mass transfer coefficients, Dimensionless groups in mass transfer, Analogy between momentum, heat and mass transfer, Introduction to Inter phase mass transfer: Relation between overall and individual mass transfer coefficient, Theories of Inter phase mass transfer.

Module-III (7 Hours)

Gas Absorption: Introduction to gas absorption, Equilibrium relations, Selection of solvent, Absorption equipment and methods of operation, Material balance in absorption column, Minimum solvent rate and actual solvent rate, Absorption of concentrated gases and lean gases, Graphical method and algebraic method for determination of number stages, HTU, NTU concepts for single component absorption.

Module-IV (10 Hours)

Distillation: Introduction, Vapour–liquid equilibrium for binary systems, T-x-y and P-x-y diagrams, Raoult's law, Relative volatility, Deviations in ideality, Azeotropic distillation, Equilibrium distillation or flash vaporization, Enthalpy concentration diagram, Steam distillation, Reflux, Continuous distillation. McCabe - Thiele method, Ponchon - Savarits method, Tray efficiencies, Analytical method determination of ideal stages, introduction to multi component distillation.

Module-V (6 Hours)

Humidification and Dehumidification: Humidification Operations: Definition of fundamental terms, Psychrometric charts, theory of adiabatic saturation and wet bulb temperature, Lewis relation, Gas liquid contact operation, Dehumidification, Adiabatic humidification. Equipment: Natural circulation, Natural draft, Mechanical draft, Spray tower, Humidity Measurement: Hygrometer method, Sling psychrometer, Dew point method.

Text Books:

1. R. E. Treybal, Mass Transfer Operations, McGraw and Hills, 1980.
2. B. K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice Hall, 2005

Reference Books:

1. W. L. McCabe & J.C. Smith, Unit Operation of Chemical Engineering, McGraw &Hills, 2005.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Understand about the molecular diffusional mass transfer.
CO2	Analyse the interfacial mass transfer mechanism.
CO3	Analyse the mechanism of absorption.
CO4	Develop and design the distillation units.
CO5	Understand the Operation of humidification & dehumidification techniques.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	1	1	3	3	2	1
CO2	3	3	2	2	3	2	1	1	3	3	2	1
CO3	3	3	2	2	3	2	1	1	3	3	2	1
CO4	3	3	2	2	3	2	1	1	3	3	2	1
CO5	3	3	2	2	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

CHEMICAL REACTION ENGINEERING –I (Code: BCM05003)

Module-I (8 Hours)

Introduction to Reaction Engineering: Classification of reactions, definitions of reactions rate, variables affecting reaction rate, speed of chemical reactions. Kinetics of homogeneous reactions: Simple reactor types, the rate equation, concentration dependent term of rate equation. Molecularity and order of reaction. Rate constant k, representation of an elementary and non-elementary reaction. Kinetic models for non-elementary reactions. Testing kinetic models. Temperature dependent term of rate equations from Arrhenius theory and comparison with collision and transition state theory. Activation energy and temperature dependency. Predictability of reaction rate from theory.

Module-II (8 Hours)

Interpretation of Batch reactor data: Constant volume batch reactor, analysis of total pressure data, Integral and differential methods of analysis of data for constant volume and variable volume cases. Temperature and reaction rate, search for a rate equation. Introduction to reactor design & Ideal reactors for single reaction: Mass and energy balances around a volume element. Ideal batch reactor, steady-state mixed flow reactor, steady-state plug-flow reactor, holding and space time for flow reactors, space-time and space velocity. Introduction to semi batch reactor.

Module-III (8 Hours)

Design of reactor for single reactions: Size comparison of single reactors, multiple reactor systems, recycle reactor and autocatalytic reactions. Design for parallel reactions: Introduction to multiple reactions, qualitative and quantitative treatment of product distribution and of reactor size, selectivity.

Module-IV (8 Hours)

Potpourri of multiple reactors: Irreversible first order reactions in series. Quantitative treatment, for plug flow or batch reactor and mixed flow reactor, their performance characteristics, kinetic studies and design. First order followed by zero order reaction, zero order followed by first order reaction, successive irreversible reactions of different orders, reversible reactions, irreversible series-parallel reactions.

Module-V (8 Hours)

Temperature and pressure effects: Single Reactions: Calculations of heats of reaction and equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure. Optimum temperature progression, Energy balances equations in adiabatic and non-adiabatic cases. Exothermic reaction in mixed flow, Rules for choice of reactors and optimum operation of rectors. Multiple Reactions: Product distribution and temperature.

Text Books:

1. O. Levenspiel, Chemical Reaction Engineering, John Wiley & Sons, 1999.

Reference Books:

1. H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall of India Pvt Limited, 1999
2. G. F. Froment and K. B. Bischoff, Chemical Reactor Analysis and Design, John Wiley, 2001.
3. J M Smith, Chemical Engineering Kinetics, McGraw& Hills, 1981

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the fundamentals of kinetics including definitions of rate and forms of rate expressions and relationships between moles, concentration, extent of reaction and conversion.
CO2	Construct the batch, CSTR, and PFR performance equations from general material balances.
CO3	Perform the calculations on isothermal plug, mixed, and batch reactors for a homogeneous and heterogeneous reaction from given rate data or a rate expression.
CO4	Identify the right reactor among single, multiple, recycle reactors etc.
CO5	Demonstrate and apply the concepts of heat capacity, latent heat, heat of reaction, heat of combustion, and heat of formation.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	1	-	-	-	2	1
CO2	3	3	2	2	-	1	1	-	-	-	2	1
CO3	3	3	2	2	-	1	1	-	-	-	2	1
CO4	3	3	2	2	-	1	1	-	-	-	2	1
CO5	3	3	2	2	-	1	1	-	-	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	-	1	1	-	-	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(PROFESSIONAL ELECTIVE I)
CHEMICAL PROCESS TECHNOLOGY (Code: BCMPE501)

Module-I (5 Hours)
Fertilizers Industry: Instrumentation diagrams and process symbols. Ammonia, Urea and NPK.

Module-II (10 Hours)

Inorganic Chemical Industries: Manufacture of Soda ash, Caustic Soda and Chlorine. Manufacture of Sulphuric acid, Hydrochloric acid and Nitric acid. Manufacture of Silicon and Calcium carbide.

Module-III (10 Hours)

Natural Products Industries: Paper & pulp industries. Manufacture of sugar and allied products. Extraction and refining of edible oil. Fat splitting and hydrogenation of oil. Soaps, detergents and recovery of glycerine.

Module-IV (5 Hours)

Fermentation Industries: Manufacture of industrial and absolute alcohol. Coal based chemical industries.

Module-V (10 Hours)
Polymerization industries: Polyethylene, polypropylene, PVC and polyester synthetic fibres.

Text books:

1. C. L. Dryden, Outlines of Chemical Technology, Edited and Revised by M. Gopala Rao and S. Marshall, 3rd Ed., Affiliated East West, New Delhi, 1997.

Reference Books:

2. T. G. Austin and S. Shreve, Chemical Process Industries, 5th Ed., McGraw Hill, New Delhi, 1984.
3. R. E. Kirk, and D. F. Othmer, Encyclopaedia of Chemical Technology, 4th Ed., Interscience, New York, 1991.
4. P. H. Groggins, Unit Processes in Organic Synthesis, 5th Ed., McGraw Hill, 1984

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the manufacturing of various fertilizers.
CO2	Demonstrate the manufacturing of inorganic chemicals.
CO3	Express the knowledge of various natural products industries.
CO4	Demonstrate the various fermentation and coal based chemical industries.
CO5	Develop the manufacturing of various polymers.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	-	1	2	2	1	1	2	2
CO2	3	3	1	1	-	1	2	2	1	1	2	2
CO3	3	3	1	1	-	1	2	2	1	1	2	2
CO4	3	3	1	1	-	1	2	2	1	1	2	2
CO5	3	3	1	1	-	1	2	2	1	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	1	1	-	1	2	2	1	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

CHEMICAL REACTION ENGINEERING –II (Code: BCMPE502)

Module-I (10 Hours)

Non-ideal Flow: Residence time distribution (RTD) of fluids in vessels, RTD models - dispersion, tanks-in-series and multi-parameter models, Conversion calculations using RTD data for first order reactions.

Module-II (8 Hours)

Introduction to heterogeneous reactions: Rate equation for surface kinetics, pore diffusion resistance combined with surface kinetics, Solid catalysed reactions: transport processes in reactions catalysed by solids; Reaction and diffusion within porous catalysts, effectiveness factor, various resistances to transfer of reactants to the catalyst site, intrinsic and global rate of reaction, kinetic regimes, heat effects during reaction,

Module-III (8 Hours)

Performance equations for reactors containing porous catalyst particles, design of solid catalytic reactors. Introduction to enzyme kinetics.

Module-IV (8 Hours)

Nature of catalysis, Determination of surface area, void volume and solid density, pore volume distribution, physical and chemical adsorption, adsorption isotherms, Physical properties of catalysts, preparation, testing and characterization of solid catalysts, catalyst selection, catalyst preparation, promoters and inhibitors, catalyst poisoning and mechanisms of catalytic reactions, catalyst deactivation.

Module-V (6 Hours)

Introduction to catalytic reactors, fluidized bed reactors, trickle bed, slurry reactors

Text Books:

1. Levenspiel, O., Chemical Reaction Engineering, John Wiley & Sons (2010).
2. Smith, J.M., Chemical Engineering Kinetics, McGraw Hill (1990).

Reference Books:

1. Fogler, H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India (2009).
2. Denbigh, K.G., and Turner, J.C.R., Chemical Reactor Theory - An Introduction, Cambridge University Press (1984).
3. Nauman, E.B., Chemical Reactor Design, John Wiley & Sons (1987).

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

CO1	Evaluate the conversion in a non-ideal reactor using tracer information.
CO2	Design reactors for fluid-solid reactions.
CO3	Design reactors for catalytic reactions.
CO4	Design reactors for gas–liquid reactions with and without mass transfer considerations
CO5	Demonstrate and apply the concepts of different catalytic reactors.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	1	-	-	-	2	1
CO2	3	3	2	2	-	1	1	-	-	-	2	1
CO3	3	3	2	2	-	1	1	-	-	-	2	1
CO4	3	3	2	2	-	1	1	-	-	-	2	1
CO5	3	3	2	2	-	1	1	-	-	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	-	1	1	-	-	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

POLYMER SCIENCE AND TECHNOLOGY (Code: BCMPE503)

Module-I (8 Hours)

Natural and synthetic Polymers. Types of Polymerization, Resinous and Crystalline state, Plastic state.

Module-II (8 Hours)

Kinetics of polymerization & poly-condensation. Introduction to reactor design for Polymerization, functionality, properties of plastics and macromolecular structure, polymer degradation.

Module-III (8 Hours)

Molecular weight of polymers and its determination by viscosity, light scattering and osmotic pressure, Monomers and their manufacture.

Module-IV (8 Hours)

Manufacture and uses of important plastic compositions like phenol formaldehyde, urea formaldehyde, venyl resins, acrylic resins, Polystyrene and polyethylene.

Module-V (8 Hours)

Compounding of plastics, plastic auxiliaries, moulding and design of moulds, casting and limitations plastizers. plastic materials and elastomers as materials of construction in chemical equipment.

Text books:

1. Bill Mayer, Polymer Science
2. Sabolev D., A First course in Polymer Chemistry, Mir Publishers

Reference Books:

1. Tager, A., Physical Chemistry of Polymers, Mir Publishers
2. Odian, G., Principles of Polymer Chemistry, McGraw Hill.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the manufacturing of various Polymers and their additives.
CO2	Demonstrate the manufacturing of plastics, Phenol, Urea.
CO3	Acquire the knowledge of various natural products industries.
CO4	Demonstrate the various unit operations and use of important chemicals.
CO5	Apply the knowledge of manufacturing of various polymer

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	1	1	2	1	1	3	2
CO2	3	2	1	1	-	1	1	2	1	1	3	2
CO3	3	2	1	1	-	1	1	2	1	1	3	2
CO4	3	2	1	1	-	1	1	2	1	1	3	2
CO5	3	2	1	1	-	1	1	2	1	1	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	1	1	-	1	1	2	1	1	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PAPER AND PULP TECHNOLOGY (Code: BCMPE504)

Module-I (8 Hours)

Processing of Raw Materials: Processes including Kraft Pulping, sulphite process

Module-II (8 Hours)

Pulp Washing and drying: Bleaching, Waste liquid treatment

Module-III (8 Hours)

Environmental aspects of pulp and paper production, Economic aspects involved builders, other additives

Module-IV (8 Hours)

Types of papers and boards for technical and specialty uses

Module-V (8 Hours)

Paper testing and elementary methods.

Text Books:

1. Pulp and Paper manufacture, Ronald Gordon Macdonald; John N Franklin; Joint Textbook Committee of the Paper Industry**,** New York, McGraw-Hill, 1969.

Reference books:

1. Handbook of Pulp and Paper Technology, 2nd ed. by K W Britt, John Wiley.
2. Handbook of Pulping and Papermaking, 2nd ed. by C J Biermann, Academic Press.
3. Handbook for Pulp & Paper Technologists, 3rd ed. by G ASmook, Angus Wilde Publications.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the manufacturing of paper technologies.
CO2	Demonstrate the manufacturing of pulp technologies.
CO3	Demonstrate the operation of various equipment.
CO4	Identify the complex environmental challenges associated with pulp and paper manufacturing.
CO5	Analyse the product properties and product qualities.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	-	1	1	1	1	1	3	2
CO2	2	3	2	2	-	1	1	1	1	1	3	2
CO3	2	3	2	2	-	1	1	1	1	1	3	2
CO4	2	3	2	2	-	1	1	1	1	1	3	2
CO5	2	3	2	2	-	1	1	1	1	1	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	3	2	2	-	1	1	1	1	1	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(OPEN ELECTIVE-I)

INDUSTRIAL POLLUTION CONTROL (Code: BCMOE501)

Module-1 (8 Hours)

Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental laws and rules, standards for ambient air, noise emission and effluents.

Module-II (8 Hours)

Pollution Prevention: Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.

Module-III (8 Hours)

Air Pollution Control: Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers.

Module-IV (8 Hours)

Water Pollution Control: Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.

Module-V (8 Hours)

Biological Treatment: Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying. Solids Disposal: Solids waste disposal - composting, landfill, briquetting / gasification and incineration.

Reference books:

1. "Pollution Control Acts, Rules, Notifications issued thereunder" CPCB, Ministry of Env. and Forest, G.O.I., 3rd Ed. 2006.
2. Valero D;" Fundamentals of Air Pollution", 4th Ed; Academic Press.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the principles and methods to control air, water and soil pollution to the undergraduate students of chemical engineering
CO2	Identify the different sources of water, air and land pollution; legislation and standards; Recycle and reuse of waste, energy recovery and waste utilization.
CO3	Identify the Air pollution and its measurement, design of pollution abatement systems for particulate matter and gaseous constituents.
CO4	Design the wastewater and industrial effluent treatment; Hazardous waste treatment and disposal. Solid-waste disposal and recovery of useful products.
CO5	Solve a number of numerical problems and study different cases.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	1	1	1	1	3	2
CO2	3	3	2	2	-	1	1	1	1	1	3	2
CO3	3	3	2	2	-	1	1	1	1	1	3	2
CO4	3	3	2	2	-	1	1	1	1	1	3	2
CO5	3	3	2	2	-	1	1	1	1	1	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	-	1	1	1	1	1	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

SESSIONALS

HEAT TRANSFER LABORATORY (Code: BCM05004)

List of experiments:

1. To find out the thermal conductivity of liquids.
2. To find out the thermal conductivity and thermal resistance of composite walls.
3. To determine the temperature distribution along the length of a fin under free convection.
4. To determine the temperature distribution along the length of a fin under forced convection.
5. To find out the heat transfer coefficient of a vertical cylinder under natural convection.
6. To find out the Stefan Boltzmann constant a black body.
7. Find out the Heat Transfer Coefficient for dropwise condensation of a platted condenser.
8. Find out the Heat Transfer Coefficient for film wise condensation of a plain condenser.
9. To find out the overall heat transfer coefficient for concentric tube heat exchanger in parallel flow arrangement.
10. To find out the overall heat transfer coefficient for concentric tube heat exchanger in counter flow arrangement.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge of thermal conductivity of solid and liquids.
CO2	Demonstrate the working of pin fin apparatus under free and forced convection mode.
CO3	Demonstrate the working principle of dropwise and filmwise condensation in a platted and a plain condenser.
CO4	Apply the knowledge of Stefan Boltzmann Law.
CO5	Demonstrate the working principle of concentric tube heat exchanger in parallel flow and counter flow arrangement.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	1	-	2	1	3	2	-	1
CO2	3	2	1	-	1	-	2	1	3	2	-	1
CO3	3	2	1	-	1	-	2	1	3	2	-	1
CO4	3	2	1	-	1	-	2	1	3	2	-	1
CO5	3	2	1	-	1	-	2	1	3	2	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	1	-	1	-	2	1	3	2	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

MASS TRANSFER LABORATORY (Code: BCM05005)

List of experiments:

1. Determination of mass transfer coefficient in a humidification and dehumidification column.
2. Determination of diffusion coefficient of an organic vapour in air
3. Determination of mass transfer coefficient in a wetted wall column
4. Determination of T-x-y diagram for a binary batch distillation
5. Verification of Rayleigh equation in a binary batch distillation process
6. Verification of steam distillation equations
7. Determination of ternary curve for the system acetic acid-water-carbon tetrachloride
8. Determination of distribution coefficient of a solute in two immiscible liquids

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Design a cooling tower used in industry
CO2	Define the vapour liquid equilibrium for various mass transfer operations
CO3	Analyze the vapour liquid equilibrium of distillation column
CO4	Understand the process and mechanism behind liquid-liquid extraction
CO5	Select the appropriate solvent required for individual solute from a solution

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	2	-	2	1	2	1	-	2	-	3
CO2	1	3	2	-	2	1	2	1	-	2	-	3
CO3	1	3	2	-	2	1	2	1	-	2	-	3
CO4	1	3	2	-	2	1	2	1	-	2	-	3
CO5	1	3	2	-	2	1	2	1	-	2	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	3	2	-	2	1	2	1	-	2	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

CHEMICAL REACTION ENGINEERING LABORATORY (Code: BCM05006)

List of experiments:

1. To determine the order of reaction and the reaction rate constant for the given saponification reaction of ethyl acetate in aqueous sodium hydroxide solution in a batch reactor.
2. To determine the order of reaction and the reaction rate constant for the given saponification reaction of ethyl acetate in aqueous sodium hydroxide solution in an isothermal batch reactor.
3. To determine the reaction rate constant for saponification of ethyl acetate with NaOH at room temperature in a CSTR.
4. To study the performance of a cascade of three equal volume CSTRs in series for the saponification of ethyl acetate with NaOH. To draw the performance chart for the reactor system and evaluate the reaction rate constant at ambient conditions.
5. To determine the reaction rate constant for saponification of ethyl acetate with NaOH at a fixed temperature in a PFR (coiled tube type). To study the effect of temperature on the reaction rate constant and determine the activation of energy for this reaction.
6. To determine the conversion in PFTR (straight tube type) for saponification of ethyl acetate with NaOH at ambient conditions.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Determine the order of reaction for a given reaction in a reactor
CO2	Determine the reaction rate constant for a given reaction
CO3	Analyse the performance of reactors
CO4	Estimate the effect of temperature on the reaction rate constant
CO5	Make comparisons of rate kinetics between isothermal and non-isothermal reactors

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	1	1	1	-	1	-	1	2
CO2	2	3	2	2	1	1	1	-	1	-	1	2
CO3	2	3	2	2	1	1	1	-	1	-	1	2
CO4	2	3	2	2	1	1	1	-	1	-	1	2
CO5	2	3	2	2	1	1	1	-	1	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	3	2	2	1	1	1	-	1	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

6TH SEMESTER THEORY

MASS TRANSFER–II (Code: BCM06001)

Module-I (8 Hours)

Drying: Drying Equilibria, Drying rate curve, Batch and continuous drying. Time of drying and calculations, mechanism of batch drying.

Module-II (8 Hours)

Adsorption: Theory of adsorption, Industrial absorbents, adsorption equilibria, freundlich equation, single and multistage operations, Ion - Exchange.

Module-III (8 Hours)

Liquid - liquid Extraction: Introduction, liquid - liquid equilibria, analytical and graphical solutions for single and multistage operations, continuous, counter current operation without reflux, fractional extraction.

Module-IV (8 Hours)

Solid-Liquid Extraction: Operation of solid, steady and unsteady state operation, analytical methods for single and multistage operations.

Module-V (8 Hours)

Mass Transfer Equipment's: Drying equipment: Equipment for batch and continuous drying operations. Adsorption equipment: Liquid-liquid extraction equipment: single stage, multistage and continuous contacting equipment. Solid liquid extraction equipment.

Text Books:

1. R. E. Treybal, Mass Transfer Operations, McGraw and Hills, 1980.
2. B. K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice Hall, 2005

Reference Books:

1. W. L. McCabe &J. C. Smith, Unit Operation of Chemical Engineering, McGraw&Hills, 2005.

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

CO1	Demonstrate the mechanism of drying operations.
CO2	Apply the fundamentals and applications of adsorption and chromatographic separation process.
CO3	Define the fundamentals of separation of components by liquid-liquid extraction.
CO4	Demonstrate the principle of leaching.
CO5	Implement the working principle of various mass transfer equipment.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	1	1	1	-	1	2	2
CO2	3	3	2	2	-	1	1	1	-	1	2	2
CO3	3	3	2	2	-	1	1	1	-	1	2	2
CO4	3	3	2	2	-	1	1	1	-	1	2	2
CO5	3	3	2	2	-	1	1	1	-	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	-	1	1	1	-	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PROCESS DYNAMICS AND CONTROL (Code: BCM 06002)

Module-I (8 Hours)

Introduction to process dynamics and control, classification of variables in a chemical process, hardware elements of a control system, physical examples of first order systems, dead time, linearization, laplace transforms, response of first order systems, interacting and non-interacting systems, second and higher order systems, dynamic systems with dead time and inverse response

Module-II (8 Hours)

Feedback control, closed loop transfer functions, types of feedback controllers and final control elements, block diagram of closed loop system, servo and regulator problems, effect of proportional control action, integral control action and derivative control action on the response of a controlled process

Module-III (8 Hours)

Stability analysis of feedback systems, characteristic equation, Routh-Hurwitz criterion, Root locus analysis, introduction to frequency response, Bode diagrams, Nyquist plots, Bode stability criterion, Nyquist stability criterion, gain and phase margins

Module-IV (8 Hours)

Controller tuning, Ziegler-Nichols tuning technique, dead time compensation, control systems with inverse response, cascade control, feed forward control, ratio control

Module-V (8 Hours)

Process identification, control valves, valve sizing, valve characteristics

Text books:

1. Chemical process control – An introduction to theory and practice, G. Stephanopoulos, PHI
2. Process systems, analysis and control, Donald R. Coughanowr, MGH

Reference Books:

1. Process dynamics and control, D.E. Seborg, T.F. Edgar, D.A. Mellichamp, John Wiley & sons
2. Process control: Modeling, design and simulation, B.B. Wayne, PHI
3. Process dynamics and control, J.M. Douglas, PHI
4. Essentials of process control, W. L. Luyben, MGH

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Knowledge of nonlinear systems, linearization, dead time, inverse response.
CO2	Ability to design controllers.
CO3	Students will be able to analyse the stability characteristics of dynamic systems.
CO4	Students will be able to understand the advanced control strategies.
CO5	Students will be able to design final control elements.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	1	1	2	2	1	1
CO2	3	3	2	1	2	1	1	1	2	2	1	1
CO3	3	3	2	1	2	1	1	1	2	2	1	1
CO4	3	3	2	1	2	1	1	1	2	2	1	1
CO5	3	3	2	1	2	1	1	1	2	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	1	1	1	2	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(PROFESSIONAL ELECTIVE-II)

TRANSPORT PHENOMENA (Code: BCMPE601)

Module-I (8 Hours)

Momentum transport: Viscosity and mechanism, Newton's law and viscosity, Non-Newtonian fluids, Temperature and pressure dependence of viscosity (gases at low density); Velocity distributions in laminar flow, Shell momentum balances, Flow of falling film, Flow through circular tube and annulus as adjacent flow of two immiscible fluids and creeping flow around a solid sphere

Module-II (8 Hours)

Equations of changes for isothermal system (compressible), Unsteady state viscous flow, Inter phase transportations in isothermal system, Friction factor. Energy transport: Thermal conductivity in solids, Fourier's law of heat conduction, Temperature and heat dependence of thermal conductivity in gases and liquids; Temperature distributions in solids and in laminar flow, Shell energy balances.

Module-III (8 Hours)

Heat conduction with electrical, viscous and chemical sources, Heat conduction through composite walls and in cooling fin, Forced and free convection, Equations of change for non-isothermal systems, Equations for energy in rectangular coordinates. Unsteady state heat conduction in solids

Module-IV (8 Hours)

Mass transport: Diffusivity and mechanism, Temperature and pressure dependence of mass diffusivity; Concentration distributions in solids and in laminar flow, Shell mass balances, diffusion through a stagnate gas film, Diffusion with homogeneous and heterogeneous chemical reactions, diffusion into a falling liquid film, Diffusion and chemical reaction inside a porous catalyst.

Module-V (8 Hours)

Equations of continuity for a binary mixture in rectangular coordinates; Inter-phase transport in multi-component system, Definition of binary mass transfer coefficients in one phase, Correlations of binary mass transfer coefficients in one phase at low mass transfer coefficients and in two phase at low and high mass transfer rates.

Text Books:

1. R. B. Bird, W. E. Stewart, and E. N. Light foot Transport phenomena, John Wiley & Sons; Revised 2ndEditionedition,2007

Reference Books:

1. Bennettand Myers, Mass, Heat and Momentum transport.
2. J. Welty, C. E. Wicks, G. L. Rorrer, and R. E. Wilson Fundamentals of Momentum Heat and Mass Transfer, John Wiley & Sons; 5th edition, 2008
3. R. S. Brodkey& H. C. Hershey, Transport Phenomena.
4. Prerequisite: Knowledge in under graduate ―Basics of Heat & Mass transfer & Fluid Dynamics.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Identify the transport properties and analyse the mechanisms of molecular momentum, energy and mass transport.
CO2	Select, locate and orient coordinate systems for transport phenomena problems (including rectangular and curvilinear).
CO3	Formulate the differential forms of the equations of change for momentum, heat and mass transfer problems for steady-state and unsteady flows.
CO4	Create original solutions to fluid flow, heat transfer and mass transfer problems, and solve problems combining these transport phenomena.
CO5	Recognize non-Newtonian liquids and apply appropriate models to describe them.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	3	2	1	1	-	2	3
CO2	3	3	2	3	1	3	2	1	1	-	2	3
CO3	3	3	2	3	1	3	2	1	1	-	2	3
CO4	3	3	2	3	1	3	2	1	1	-	2	3
CO5	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

BIO-MATERIALS (Code: BCMPE602)

Module-I (8 Hours)

Introduction, biomaterials in medicine; Metallic implant materials: different types, Host tissue reaction with bio metal, corrosion behaviour and the importance of passive films for tissue adhesion. Hard tissue & Soft tissue replacement.

Module-II (8 Hours)

Polymeric implant materials: Types and classification, Mechanical, Surface, Electrochemical & Physicochemical properties of biopolymers.

Module-III (8 Hours)

Biodegradable polymers for medical application. Synthetic polymeric membranes and their biological applications; Ceramic implant materials:

Module-IV (8 Hours)

Types of bio ceramics, Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction; Composite implant materials: Mechanics of improvement of properties by incorporating different elements.

Module-V (8 Hours)

Composite theory of fibre reinforcement. Polymers filled with osteogenic fillers. Host tissue reactions; Testing of Biomaterials: biocompatibility, blood compatibility and tissue compatibility, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilisation of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization.

Text Books:

2. S. V. Bhat, Biomaterials, Springer, 2002.

3. JB ParkandJ. D. Boonzino, Biomaterials: Principles and Application, CRC Press, 2002

Reference Books:

1. J. Black, Biological Performance of materials, Taylor & Francis, 2006
2. C. P. Sharma and M. Szycher, Blood compatible materials and devices, Technomic Publishing Co. Ltd., 1991.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Understand the different types of Bio-materials and their properties.
CO2	Understand different types of Bio-polymers and their applications.
CO3	Apply the knowledge on processing of fibre reinforcement of composite Polymers
CO4	Understand different types of ceramic materials and Biomaterials.
CO5	Apply their knowledge on improvement of various properties.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	3	2	1	1	-	2	3
CO2	3	3	2	3	1	3	2	1	1	-	2	3
CO3	3	3	2	3	1	3	2	1	1	-	2	3
CO4	3	3	2	3	1	3	2	1	1	-	2	3
CO5	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

NANO-TECHNOLOGY IN CATALYSIS (Code: BCMPE603)

Module-I (8 Hours)

Introduction to nanotechnology, definition, history. What makes the nano-scale so different from the other length scales by considering the underpinning science (i.e. nano-science) and some key examples of nanotechnology.

Module-II (8 Hours)

Methods of synthesis of nano materials Fabrication-Top-down vs. bottom-up approaches. Equipment and processes needed to fabricate nano devices and structures. Fundamental understanding of catalysis at nano-scale.

Module-III (8 Hours)

Wet chemical synthesis, preparation and properties of iron, platinum, gold, cadmium, silver, copper and nickel nano-particles.

Module-IV (8 Hours)

Synthesis and properties of composite nano-particles and coated nano-particles.

Module-V (8 Hours)

Characterization of nano particles by Scanning probe microscopes (Atomic Force Microscopy, Scanning Tuneling Microscopy), Transmission Electron Microscopy, Scanning Electron.

Text Books:

1. S. K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Co. 2007.

Reference books:

1. Tang, Zikang and Sheng, Ping, Taylor and Francis, Nano science and technology: novel Structures and phenomena, 2003. 2.

2. B. Rogers, S. Pennathur, J. Adams, Taylor and Francis, Nanotechnology: Understanding small systems, 2008.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Analyse the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.
CO2	Identify appropriate synthesis techniques to synthesize quantum nanostructures of desired size, shape and surface properties.
CO3	Understand and employ the concepts of nanotechnology in engineering applications.
CO4	Apply their knowledge on design concepts of nano reactors
CO5	Understand the concept and characterization of nanoparticles and nano-fluids.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	3	2	1	1	-	2	3
CO2	3	3	2	3	1	3	2	1	1	-	2	3
CO3	3	3	2	3	1	3	2	1	1	-	2	3
CO4	3	3	2	3	1	3	2	1	1	-	2	3
CO5	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

FERTILIZER TECHNOLOGY (Code: BCMPE604)

Module-I (8 Hours)

Chemical fertilizers and organic manures–types of chemical fertilizers, nitrogenous fertilizers–methods of production of ammonia and urea.

Module-II (8 Hours)

Nitrogen sources-nitric acid, ammonium sulphate, ammonium sulphate nitrate, ammonium nitrate, ammonium chloride–their methods of production, characteristics, and storage and handling specifications.

Module-III (8 Hours)

Phosphatic fertilizers-raw materials, phosphate rock, sulphur pyrites, process for the production of sulphuric and phosphoric acids, ground phosphate rock, bone, single super phosphate, triple super phosphate–methods of production, characteristics and specifications.

Module-IV (8 Hours)

Potassic fertilizers, potassium chloride, potassium sulphate, potassium schoenite – methods of production, specification, characteristics

Module-V (8 Hours)

Complex fertilizers, NPK fertilizers, mono ammonium phosphate, di-ammonium phosphate, nitro phosphate – methods of production.

Text Books:

1. Collings, G.H., Commercial Fertilizers, 5th Edn., McGraw Hill, New York, 1955.
2. Editorial Board-Handbook of fertilizer technology, The Fertilizer Association of India, New Delhi, 1977.
3. Slacks, A. V., Chemistry and Technology of Fertilizers, Interscience, New York, 1966.

Course Outcome: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the manufacturing of various organic fertilizers.
CO2	Demonstrate the manufacturing of various nitrogen sources fertilizers.
CO3	Demonstrate the manufacturing of various Phosphatic fertilizers.
CO4	Demonstrate the manufacturing of various Potassic fertilizers.
CO5	Demonstrate the manufacturing of various Complex fertilizers.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	1	1	1	1	1	2	2
CO2	3	2	2	2	-	1	1	1	1	1	2	2
CO3	3	2	2	2	-	1	1	1	1	1	2	2
CO4	3	2	2	2	-	1	1	1	1	1	2	2
CO5	3	2	2	2	-	1	1	1	1	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	2	-	1	1	1	1	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(PROFESSIONAL ELECTIVE-III)

PROCESS EQUIPMENT DESIGN (Code: BCMPE605)

Open books

Following books are allowed:

1. Process equipment design, M. V. Joshi, V. V. Mahajani, S. B. Umarji, Macmillan India ltd.
2. Introduction to chemical equipment design – Mechanical aspects, B. C. Bhattacharya, CBS pub.
3. Coulson and Richardson's chemical engineering – Chemical engineering design, Vol. 6, R. K. Sinnott, Elsevier

Module-I (8 Hours)

Design of storage tanks and pressure vessels.

Module-II (8 Hours)

Process design of Heat exchangers: Double pipe, Shell and tube type, Condenser for single vapor only.

Module-III (8 Hours)

Process design of evaporators: Single and multi-effects.

Module-IV (8 Hours)

Process design of distillation columns: binary system only.

Module-V (8 Hours)

Process design of absorption columns: binary system without chemical reaction.

Text Books:

1. Process equipment design, Lloyd E. Brownell, Edwin H. Young, John Wiley & sons
2. Process equipment design, Herman C. Hesse, J. Henry Rushton, East-West press pvt. ltd.
3. Process heat transfer, D. Q. Kern, MGH
4. Mass Transfer Operations, R. E. Treybal, MGH

Reference Books:

1. J. H. Perry, Chemical Engineers Handbook.
2. McCabe W. L. & Smith J. C. &Harriot P, Unit Operations of Chemical Engineering (7^{th} Edition), McGraw Hill, New York.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to

CO1	Apply the knowledge on the different design concepts in equipment design.
CO2	Develop the design of heat exchangers.
CO3	Develop the design of evaporators.
CO4	Develop the design of distillation columns.
CO5	Develop the design of absorption columns.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	1	1	2	-	1	1
CO2	3	3	2	1	2	1	1	1	2	-	1	1
CO3	3	3	2	1	2	1	1	1	2	-	1	1
CO4	3	3	2	1	2	1	1	1	2	-	1	1
CO5	3	3	2	1	2	1	1	1	2	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	1	1	1	2	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

DISASTER MANAGEMENT IN CHEMICAL INDUSTRIES (Code: BCMPE606)

Module-I (8 Hours)

General aspects of industrial disaster: Due to fire, explosion, toxicity and radiation; Chemical hazards: Classification of chemical hazards, Chemical as cause of occupational diseases –dust, fumes, gases and vapours

Module-II (8 Hours)

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

Module-III (8 Hours)

Pressure vessels, Storage, Handling, Transportation, Electrical systems, Instrumentation; Emergency planning.

Module-IV (8 Hours)

Personal protective devices, Maintenance procedure; Emergency safety and laboratory safety; Legal aspects of safety'

Module-V (8 Hours)

Management information system and its application in monitoring disaster, safety and health Hazop Analysis.

Text Books:

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

Reference Books:

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

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Understand the scenario and challenges associated with chemical disaster risks and consequences.
CO2	Develop the environmental planning with disaster management in siting of Industries and Industrial estates.
CO3	Identify the chemical disaster risks, mitigation measures and response mechanisms.
CO4	Develop capabilities for the evaluation of the effectiveness of onsite and offsite plans
CO5	Solve the preparedness for chemical emergencies and response of various services in chemical disasters.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	3	2	1	1	-	2	3
CO2	3	3	2	3	1	3	2	1	1	-	2	3
CO3	3	3	2	3	1	3	2	1	1	-	2	3
CO4	3	3	2	3	1	3	2	1	1	-	2	3
CO5	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	1	3	2	1	1	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

FOOD BIOTECHNOLOGY (Code: BCMPE607)

Module-I (8 Hours)

Food quality and Production technology, Analysis of food, major ingredients present in different product, Food additives colour, flavour, vitamins, Single cell protein, mushroom, Fermentative production of food, Pickling and alcoholic beverages, genetically manipulated crop based food, oriental foods, probiotics/prebiotics in food products.

Module-II (8 Hours)

Technology for improved process Enzyme in bakery, fermented cereal products, Enzymes in fat/oil industries, Protease in cheese making, enzymes in beverage production, Utilization of food waste for production of value added products, enzymes in sugar syrup, genetically modified food.

Module-III (8 Hours)

Food spoilage and control Spoilage of food, Microbiology of water, meat, milk, vegetables, Microbial safety of food products.

Module-IV (8 Hours)

Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination

Module-V (8 Hours)

Food preservatives and additives, Post-harvest technology for food preservation. Technology – canning, dehydration, ultrafiltration, sterilization, irradiation etc.

Text Books:

1. Jay, Modern Food Microbiology, CBS Publishers, 1987
4. Frazier, Food Microbiology
3. G. Reed, Prescott and Dunn‘s Microbiology, CBS publishers, 1987

Reference Books:

1. Desrosier, Technology of food preservation, CBS publishers
2. R.P. Singh and D.R. Headman, Introduction to food engineering.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Understand the fundamentals of food science.
CO2	Understand the different processes of food.
CO3	Apply the knowledge of various electrical and magnetic properties of materials.
CO4	Develop new products using different techniques..
CO5	Analyze the food quality.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	3	2	-	1	1	2	3
CO2	3	3	2	3	1	3	2	-	1	1	2	3
CO3	3	3	2	3	1	3	2	-	1	1	2	3
CO4	3	3	2	3	1	3	2	-	1	1	2	3
CO5	3	3	2	3	1	3	2	-	1	1	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	1	3	2	-	1	1	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

MATERIALS SCIENCE AND ENGINEERING (Code: BCMPE608)

Module-I (8 Hours)

Introduction to materials science and engineering: bonding and structure of materials, crystal structure and crystal geometry: space lattice; unit cells; crystal systems; bravis lattices; miller indices; volume, planar and linear density unit cell calculations

Module-II (8 Hours)

Polymorphism; crystal structure analysis, crystalline imperfections, defect chemistry, diffusions in solids; phase equilibrium and transformation.

Module-III (8 Hours)

Solidification: solidification of metals and single crystals; solid solutions physical properties of materials, mechanical properties of materials, electrical and semiconducting properties of materials, dielectric and magnetic properties of materials, crystal structure analysis, crystalline imperfections, defect chemistry, diffusions in solids; phase equilibrium and transformation.

Module-IV (8 Hours)

Solidification: Solidification of metals and single crystals; Solid solutions Physical properties of materials, Mechanical properties of materials, Electrical and semiconducting properties of materials, Dielectric and Magnetic properties of materials, Optical and thermal behaviour of materials, piezoelectric and electro optic behaviour of materials, Superconducting materials, electrochemical properties etc.

Module-V (8 Hours)

Engineering materials: alloys and intermetallic, ceramic materials, glasses, polymers and composites etc.

Text Books:

1. W. F. Smith, Foundations of Materials Science and Engineering, McGraw-Hill Professional,2003.
2. V. Raghavan, Materials Science and Engineering, 4th Ed, Prentice-Hall of India Pvt.Ltd, New Delhi, 2004.

Reference Books:

1. L. H. V. Vlack, Elements ofMaterials Science and Engineering, 6th Edition, Prentice Hall,1989
2. J. F. Shackelford and M. Meier, Introduction to Materials Science for Engineers, Prentice Hall PTR, 2005.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Understand the fundamentals of materials.
CO2	Understand the different processes of polymorphism.
CO3	Apply the knowledge of various electrical and magnetic properties of materials.
CO4	Develop various materials based on engineering applications.
CO5	Identify the electrical and magnetic properties of the materials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	2	1	-	2	3	1	-	-
CO2	3	1	2	3	2	1	-	2	3	1	-	-
CO3	3	1	2	3	2	1	-	2	3	1	-	-
CO4	3	1	2	3	2	1	-	2	3	1	-	-
CO5	3	1	2	3	2	1	-	2	3	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	1	2	3	2	1	-	2	3	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

CHARACTERIZATION TECHNIQUES (OPEN ELECTIVE-II)

(Code: BCMOE601)

Module-I (8 Hours)

Materials characterization: importance and applications; principles of X-ray diffraction (XRD) methods; microscopy techniques: optical and electrons (SEM and TEM) microscopy;

Module-II (8 Hours)

Introduction to spectroscopy: UV-vis, IR and Raman Spectroscopy, FTIR

Module-III (8 Hours)

Thermal stability analysis: thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC).

Module-IV (8 Hours)

BET surface area; Chemisorption; particle size; zeta potential. Rheology and interfacial analysis: Principles, Applications, Analysis of liquid and solid samples.

Module-V (8 Hours)

Mechanical property characterization: principles and characterization of tensile, compressive, hardness, fatigue, and fracture toughness properties; principles of characterization of other materials properties.

Texts/References:

1. Y. Leng, Materials Characterization: Introduction to microscopic and spectroscopic methods, 1st Ed., John Wiley & Sons, 2008.
2. A.W. Adamson and A.P. Gast, Physical Chemistry of Surfaces, John Wiley, New York, 1997. 3. D.G. Baird and D.I. Collias, Polymer Processing Principles and Design, Butterworth-Heinemann, Massachusetts, 1995.
3. A.J. Milling, Surface Characterization Methods: Principles, techniques, and applications, Marcel Dekker, 1999.
4. G. Ertl, H. Knozinger and J. Weitkamp, Handbook of Heterogeneous Catalysis, Vol. 2, WileyVCH, 1997.
5. W.D. Callister (Jr.), Material Science and Engineering: An introduction, 8th Ed., John Wiley & Sons, 2010.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Operate various analytical instruments.
CO2	Characterize liquid samples using spectroscopy techniques.
CO3	Characterize solid samples using analytic techniques.
CO4	Understand the Rheology and interfacial analysis.
CO5	Characterize Mechanical property of various materials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	-	2	1	-	1	2	3	-	2
CO2	2	1	3	-	2	1	-	1	2	3	-	2
CO3	2	1	3	-	2	1	-	1	2	3	-	2
CO4	2	1	3	-	2	1	-	1	2	3	-	2
CO5	2	1	3	-	2	1	-	1	2	3	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	1	3	-	2	1	-	1	2	3	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

SESSIONAL

COMPUTER AIDED DESIGN LABORATORY (Code: BCM06003)

List of experiments:

1. Recycle calculations using Chemcad
2. Flash drum calculations using Chemcad.
3. Distillation: To find the number of stages and feed tray location using Chemcad.
4. Multi component distillation column: To separate a mixture using Chemcad.
5. Steady state reactors: To find out size of CSTR and PFR using Chemcad.
6. Configuring Batch Reactor using Chemcad.
7. Double pipe heat exchanger: To find out the tube diameter using Chemcad.
8. Shell and Tube heat exchanger: To find out the number of tube and tube diameter using Chemcad.
9. Piping network design and analysis using Chemcad.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement the software to accomplish day-to-day tasks, and tackle the toughest chemical process models.
CO2	Create and work with process flow diagrams (PFDs)
CO3	Design heat exchangers, pressure vessels, valves, pumps, column trays, packing etc.
CO4	Calculate thermo physical properties (Bubble point/ Dew point) and perform data regression
CO5	Plot graphs and Analyse the systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	2	1	2	1	-	2	1
CO2	2	2	3	3	3	2	1	2	1	-	2	1
CO3	2	2	3	3	3	2	1	2	1	-	2	1
CO4	2	2	3	3	3	2	1	2	1	-	2	1
CO5	2	2	3	3	3	2	1	2	1	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	2	3	3	3	2	1	2	1	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PROCESS CONTROL LABORATORY (Code: BCM06004)

List of experiments:

1. Study of open loop response
2. Study of on/off controller
3. Study of P-controller
4. Study of PI-controller
5. Study of PD-controller
6. Study of PID-controller
7. Tuning of controller (open loop method)
8. Tuning of controller (closed loop method)
9. Tuning of controller (using auto tuning method)
10. Study of stability of the system (Bode plot)

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Demonstrate the open loop response and closed loop response.
CO2	Demonstrate the working principle of on/off controller.
CO3	Demonstrate the working principle of P, PI and PID controllers.
CO4	Demonstrate the tuning of controller.
CO5	Demonstrate the stability characteristics of the system using Bode plot.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	1	1	3	3	2	1
CO2	3	3	2	2	3	2	1	1	3	3	2	1
CO3	3	3	2	2	3	2	1	1	3	3	2	1
CO4	3	3	2	2	3	2	1	1	3	3	2	1
CO5	3	3	2	2	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PROCESS EQUIPMENT DESIGN LABORATORY (Code: BCM06005)

List of experiments:

Design of mass transfer equipment:

1. Continuous contractors
2. Absorption
2. Leaching
3. Liquid-Liquid extraction
4. Distillation
5. Drying
6. Humidification
7. Acquaintance with software in the design of various mass transfer equipment.

Design of heat exchangers:

1. Shell and Tube heat exchanger
2. double pipe heat exchanger
3. plate type heat exchanger
4. Types of pitch and baffles
5. Evaporators and Condensers

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply design principles for design and construction of process equipment
CO2	Design process equipment in different process conditions
CO3	Analyse the performance of process equipment in different process conditions
CO4	Estimate the economy of process equipment
CO5	Suggest the suitability of process equipment in a given condition

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	3	1	2	-	1	1	1
CO2	3	2	3	1	2	3	1	2	-	1	1	1
CO3	3	2	3	1	2	3	1	2	-	1	1	1
CO4	3	2	3	1	2	3	1	2	-	1	1	1
CO5	3	2	3	1	2	3	1	2	-	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	1	2	3	1	2	-	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

7TH SEMESTER THEORY

PROCESS SIMULATION AND MODELLING (Code: BCM107001)

Module-I (6 Hours)

Simulation: Techniques of digital simulation – Information flow, from process to information flow diagram, from information flow diagram to numerical form, Recycles, Calculation of a recycle set, etc.

Module-II (6 Hours)

Modeling: Fundamentals of mathematical models and formulation – Continuity equation, Equation of motion, Transport equations, Energy equation, Equations of state, Equilibrium, Chemical kinetics and their applications

Module-III (12 Hours)

Lumped and distributed parameter models – Fluid systems, C. S. T. R. (single, series, isothermal, constant hold up, variable hold up, gas phase pressurized and non-isothermal), Single component vaporizer, Multi-component flash drum, Batch reactor, Reactor with mass transfer, Ideal binary distillation column, Batch distillation, Heat exchanger, etc

Module-IV (10 Hours)

Optimization: Single variable optimization (analytical, dichotomous search, Fibonacci, golden section, regular falsi), Multivariable optimization (analytical, geometric programming, linear programming), Convergence methods (Newton's methods, direct substitution, Wegstein's method).

Module-V (6 Hours)

Simulation of C. S. T. R. in series, non-isothermal CSTR, Binary distillation column, Batch reactor, Computer aided design

Text Books:

3. W. L. Luyben, Process Modelling, Simulation and Control for Chemical Engineers, McGraw Hill, 1990.

Reference Books:

1. B. V. Babu, Process Plant Simulation, Oxford University Press, 2004.
2. S. S. Rao, Engineering Optimization: Theory and practice, New Age Publishers, 1999.
3. Hussain and K. Gangaiah, Optimisation Techniques for Chemical Engineers, Macmillan, 2001.
4. W. Bequette, Process Control: Modelling, Design and Simulation. Prentice-Hall India, 2006.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Solve the problem statements of important physical phenomena
CO2	Develop model equations for various chemical engineering systems
CO3	Solve the various processes/unit operation models
CO4	Do the process simulation of various chemical systems and industry as well
CO5	Develop the specific model equations for heat transfer, mass transfer, fluid mechanics and reactor related problems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	3	1	1	-	-	2	2
CO2	2	2	3	3	3	3	1	1	-	-	2	2
CO3	2	2	3	3	3	3	1	1	-	-	2	2
CO4	2	2	3	3	3	3	1	1	-	-	2	2
CO5	2	2	3	3	3	3	1	1	-	-	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	2	3-	3	3	3	1	1	-	-	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PETROLEUM REFINERY ENGINEERING (Code: BCM07002)

Module-I (8 Hours)

Origin of Petroleum: Mendeleev and Englers' theories, Composition of petroleum, Indian oil fields, Composition of Indian crudes, Properties of crude and products; Evaluation of oil stocks: Base of crude oil, Characterization factor– TBP apparatus, Gravity and mid-percent curve, Yield curve, Equilibrium flash vaporization curve

Module-II (8 Hours)

ASTM distillation, Characteristics of products, ASTM end points and TBP cut point; Crude oil processing: Desalting and dehydration of crude, Tropping, Atmospheric and vacuum distillation

Module-III (8 Hours)

Cracking and Reforming: Important cracking and reforming reactions, Thermal cracking, Fixed bed, Moving bed and Fluidized bed catalytic cracking, Catalytic reforming, Processes like Poly forming and hydro forming; Conversion of petroleum gases into motor fuels with special references to Alkylation, Polymerization and Isomerisation;

Module-IV (8 Hours)

Chemical treatment: Sulphuric acid treatment, sweetening treatment like Solutizer process, Doctor's treatment and Catalytic desulphurization, Solvent extraction: Selection of solvents, Eldeleanu process, Furfural processes; Characteristics of important products like gasoline, kerosene, diesel, jet fuels and lubricating oils.

Module-V (8 Hours)

Environmental issues and New Trends in petroleum refinery operations: Ecological consideration in petroleum refinery, Wastewater treatment, control of air pollution, New trends in refinery, Alternative energy sources, Biodiesel, Hydrogen energy from biomass.

Text Books:

1. W. L. Nelson, Petroleum Refinery Engineering.
2. B.K. BhaskarRao, Morden Petroleum Refining Process,6th Edition.

Reference Books:

1. J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC 2007.
2. Dr. Ram Prasad, Petroleum Refining Technology, Khanna Publisher,2002.
3. IndraDeoMall, Petroleum Refining Technology, CBS Publisher 1st edition 2015.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply his knowledge in various processes of petroleum industries

CO2	Characterize the petroleum products such as gasoline, kerosene, diesel, jet fuels and lubricating oils
CO3	Apply his idea for solving the problems involved in various petroleum processing units
CO4	Categorize the refinery products, and can suggest the suitable test methods
CO5	Suggest the suitable process for the distillation of various types of petroleum

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	-	1	2	2	1	1	2	2
CO2	3	3	1	1	-	1	2	2	1	1	2	2
CO3	3	3	1	1	-	1	2	2	1	1	2	2
CO4	3	3	1	1	-	1	2	2	1	1	2	2
CO5	3	3	1	1	-	1	2	2	1	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	1	1	-	1	2	2	1	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(PROFESSIONAL ELECTIVE-IV)

MINERAL PROCESS ENGINEERING (Code: BCMPE701)

Module-I (8 Hours)

Introduction and scope of mineral processing in extractive metallurgy. Ores and mineral resources in India and worldwide for basic metals like iron, copper, aluminium, lead, and zinc.

Module-II (8 Hours)

Physical and chemical characteristics of industrial minerals. Liberation and its significance. Size reduction: Crushing laws and crushing and grinding equipment. Screening theory and equipment. Classifiers: mechanical and hydraulic.

Module-III (8 Hours)

Gravity concentration methods: tabling, jigging, heavy media separation, hydro cyclones, and spiral concentrators. Flotation: theory and equipment. Magnetic separation: HGMS, WHIMS, and SC-HGMS. Electrostatic separation: ion-bombardment and tribo electrostatic separators. Sedimentation theory and equipment. Thickeners and clarifiers.

Module-IV (8 Hours)

Thermal methods in processing of ores: Roasting, sintering, calcination, palletisation, and briquetting. Chemical and electrochemical methods in mineral processing: Leaching – acid and bacterial leaching, amalgamation and cyanidation.

Module-V (8 Hours)

Beneficiation flow sheets of coal and simple ores of copper, lead, zinc, and iron with reference to Indian deposits.

Text Books:

1. Mineral processing technology by B.A. Wills and T. J. Napier-Mum

Reference Books:

1. Handbook of hydrometallurgy.
2. Gaudin, A. M. and Prior, B.J., Principle of Mineral Dressing.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the basic principles behind various major mineral separation processes and respective equipment used in unit operations
CO2	Apply the different chemical and electrochemical methods used in mineral processing.
CO3	Recognise various processing techniques to elaborate a complete flow-sheet to recover of valuable mineral and metal from a particular ore
CO4	Recognise a logical link between applied mineralogy, mineral processing and economics of metal production.
CO5	Apply the knowledge learned as to being capable of understanding advance courses on mineral processing operations and modelling.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	1	1	3	3	2	1
CO2	3	3	3	2	3	2	1	1	3	3	2	1
CO3	3	3	3	2	3	2	1	1	3	3	2	1
CO4	3	3	3	2	3	2	1	1	3	3	2	1
CO5	3	3	3	2	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	3	2	1	1	3	3	2	1

CORROSION & DEGRADATION OF MATERIALS (Code: BCMPE702)

Module-I (8 Hours)

Technological importance of corrosion study, corrosion as non-equilibrium process, corrosion rate expressions, electrochemical principles of corrosion-cell analogy, concept of single electrode potential, reference electrodes, e.m.f. and galvanic series-their uses in corrosion studies, polarization, passivity.

Module-II (8 Hours)

Different forms of corrosion-uniform attack, galvanic, crevice, pitting, inter granular, selective leaching, erosion, stress corrosion cracking-their characteristic features, causes and remedial measures.

Module-III (8 Hours)

Principles of corrosion prevention-material selection control of environment including inhibitors, cathodic and anodic protection, coatings and design considerations. Corrosion testing methods

Module-IV (8 Hours)

Introduction to high temperature corrosion, Pilling-Bedworth ratio, oxidation kinetics, oxide defect structures, Wagner-Hauffe valence approach in alloy oxidation, catastrophic oxidation, internal oxidation. Considerations in high temperature alloy design, prevention of high temperature corrosion -use of coatings.

Module-V (8 Hours)

Liquid metal attack - liquid metal embrittlement, preventive measures. Chemical degradation of non-metallic materials like rubbers, plastics, ceramics etc. Hydrogen damage - types, characteristics, mechanism and preventive measures.

Text Books:

1. Corrosion Engineering by Fontana, M.G., McGraw-Hill,
2. Corrosion & Corrosion Control by H.H. Uhlig, John Wiley & Sons.
3. Introduction to Metallic Corrosion by Evans.

Reference Books:

1. Introduction to Electrochemistry by S. Glasstone.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Classify and explain Characteristic features, causes and remedial measures of different forms of corrosion.
CO2	Describe the principal and different methods of corrosion protection
CO3	Understand and explain working of different metallic coating processes.
CO4	Explain corrosion rate expressions and testing methods.
CO5	Explain principles and different terms of corrosion.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	3	2	1	1	3	3	2	1
CO2	3	3	3	-	3	2	1	1	3	3	2	1
CO3	3	3	3	-	3	2	1	1	3	3	2	1
CO4	3	3	3	-	3	2	1	1	3	3	2	1
CO5	3	3	3	-	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	-	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PARTICULATE SCIENCE & TECHNOLOGY (Code: BCMPE703)

Module-I (8 Hours)

Study of particles: Definition of a particle, Qualities of particles; The industrial revolutions: explosion of particle related advances (from advanced mining techniques to abrasives, cutting tools, and mass production of chemicals and agricultural products).

Module-II (8 Hours)

Modern scientific advances in paints and coatings and other particles in various base solvents, particles in fluids.;

Module-III (8 Hours)

Composite materials, the design and manipulation of matter on the nano scale and into nano-structures.

Module-IV (8 Hours)

Particle Science as an enabling technology to create new energy sources, clean our air and water and build stronger and lighter materials.

Module-V (8 Hours)

Advances in particle sciences in particular in the area of human healthcare.

Text Book:

1. J. K. Beddow, Particulate Science and Technology**.**

Reference Book:

1. M. Leva, Fluidization.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Describe the basic ways in which particles behave.
CO2	Recognize the causes of fires and explosions of fine powders
CO3	Discuss how to select processes which minimize powder related problems
CO4	Relate single particles and beds of particles in their interaction with fluids
CO5	Describe separation techniques like filtration and gas cyclones

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	2	1	1	3	3	2	1
CO2	3	3	3	3	-	2	1	1	3	3	2	1
CO3	3	3	3	3	-	2	1	1	3	3	2	1
CO4	3	3	3	3	-	2	1	1	3	3	2	1
CO5	3	3	3	3	-	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	3	-	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

MEMBRANE TECHNOLOGY (Code: BCMPE 704)

Module-I (8 Hours)

Introduction to membranes; membrane materials: polymeric, inorganic and liquid

Module-II (8 Hours)

Membrane preparation: phase inversion, immersion precipitation, track-etch method, sol-gel process, interfacial polymerization, dip-coating process, film stretching and template leaching characterization of membranes; transport in membranes; various membrane processes and applications

Module-III (8 Hours)

Membrane fouling, concept, types of fouling. Factor responsible for fouling such as temperature, pressure, materials used for fouling, concentration of feed.

Module-IV (8 Hours)

Mechanism involved effect of fouling, reversible, irreversible fouling. Concept of bio fouling factor responsible for bio fouling, control of bio fouling. process design; membrane reactors and membrane bioreactors.

Module-V (8 Hours)

Economics of membrane, cost of membrane. Feasibility of membrane. Compare membrane with conventional processes. Scope of membrane, future to membrane technology.

Text Books:

1. M. H. Mulder, Basic Principles of Membrane Technology, Springer, 2004.
2. B. K. Dutta, Mass Transfer and Separation Processes, PHI, 2007.

Reference Books:

1. M. Cheryan, Ultra filtration & Microfiltration Handbook, Technomic, 1998.
2. K. Nath, Membrane Separation Processes, PHI, 2008.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Understand about various aspects of membrane technology.
CO2	Employ the concepts of membrane technology in engineering applications.
CO3	Recognize appropriate method to reduce membrane fouling.
CO4	Apply concept of economics and feasibility to membrane technology.
CO5	Interpret the concept of advance membrane technology and nanotechnology.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	1	2	-	2	1	2	3	-
CO2	3	2	1	3	1	2	-	2	1	2	3	-
CO3	3	2	1	3	1	2	-	2	1	2	3	-
CO4	3	2	1	3	1	2	-	2	1	2	3	-
CO5	3	2	1	3	1	2	-	2	1	2	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	1	3	1	2	-	2	1	2	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(OPEN ELECTIVE-III)

RENEWABLE ENERGY (Code: BCMOE701)

Module-I (8 Hours)

Introduction to Energy Science and Energy Technology; Energy Science and Energy Technology, world energy future, Energy sources and their availability.

Module-II (8 Hours)

Renewable energy sources. Prospects of Renewable energy sources; Solar energy fundamentals and application; Geothermal energy: Introduction, Utilization of Geothermal energy, Geothermal energy resources, geothermal gradient, Different types of Geothermal Electric power plant and their operations for Geothermal Energy systems in India.

Module-III (8 Hours)

Wind energy: Fundamentals and application, Basic principles of Wind Energy Conversion, Wind Energy conversion system, Performance of wind machines, Electric generation for wind, Energy from the oceans: Introduction Ocean Energy conversion Technologies. Types of Ocean Thermal Electric Power Generation system and their operation. Tidal power plant; Hydro Energy: Introduction, Types hydroelectric plants and energy conversion scheme, Impulse turbine and Reaction turbine. Classification of Hydro-Energy plants.

Module-IV (8 Hours)

Biomass Energy Resources: Introduction, Biomass Conversion Process. Biogas from plant Wastes, communities' biogas plants. Biochemical conversion, Fermentation, liquid fuels for biomass; Urban Waste: A source of Energy. Urban solid waste, waste incineration process. Environmental consideration, Fluidized bed combustion boilers for burning solid waste and fossil fuels.

Module-V (8 Hours)

Energy Conservation: Principle of energy conservation and Energy Audit. Energy conservation Technologies. Co-generation, waste heat utilization, Heat recuperates, Heat regenerators, Heat Pipes, Heat pumps, Energy storage.

Text Books:

1. S. Rao and Dr. B. B. Parulekar, Energy Technology, Non-conventional, Renewable and Conventional, Khanna Publishers.

Reference Books:

1. G. D. Rai, Non-conventional Energy Sources, Khanna Publishers.
2. D. S. Chauhan and S. K. Srivastava, Non- Conventional Energy Resources, New Age InternationalPvt Ltd.
3. G. N. Tiwari, Fundamentals of Renewable Energy Sources, Narosa Publishing House.

Course Outcomes: Upon completion of the course the students will demonstrate the ability to:

CO1	Develop the use of renewable energy systems in society.
CO2	Perform an initial design of a renewable energy system.
CO3	Analyse how changes in functionality in a component will affect the other components of the system.
CO4	Use laboratories and emulators of renewable energy systems to analyze relevant issues.
CO5	Conduct an independent, limited research or development project under supervision and in accordance with current research ethical standards in renewable energy systems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	1	3	1	2	2	3	1	1	-
CO2	3	-	2	1	3	1	2	2	3	1	1	-
CO3	3	-	2	1	3	1	2	2	3	1	1	-
CO4	3	-	2	1	3	1	2	2	3	1	1	-
CO5	3	-	2	1	3	1	2	2	3	1	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	-	2	1	3	1	2	2	3	1	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

SESSIONAL

PROCESS SIMULATION LABORATORY (Code: BCM07003)

List of experiments:

1. Steady state simulation of Heat Exchanger using ASPEN PLUS/ HYSYS/MATLAB;
2. Steady state simulation of a CSTR using ASPEN PLUS/ HYSYS/MATLAB;
3. Steady state simulation of Flash vessel using ASPEN PLUS/ HYSYS/MATLAB
4. Steady state simulation of Distillation Column using ASPEN PLUS/ HYSYS/MATLAB
5. Steady state simulation of an Absorption column using ASPEN PLUS/ HYSYS
6. Dynamic simulation of Heat Exchanger using ASPEN PLUS/ HYSYS/MATLAB
7. Dynamic simulation of a CSTR using ASPEN PLUS/ HYSYS/MATLAB
8. Dynamic simulation of Flash vessel using ASPEN PLUS/ HYSYS/MATLAB
9. Dynamic simulation of Distillation Column using ASPEN PLUS/ HYSYS/MATLAB
10. Dynamic simulation of an Absorption column using ASPEN PLUS/ HYSYS/MATLAB

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply various simulation tools for solving the chemical engineering models developed
CO2	Demonstrate the principles of process simulators.
CO3	Demonstrate the solution techniques for solving ODEs.
CO4	Write program structures to solve chemical engineering problems
CO5	Plot graphs and Analyse the systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	3	1	1	-	-	2	2
CO2	2	2	3	3	3	3	1	1	-	-	2	2
CO3	2	2	3	3	3	3	1	1	-	-	2	2
CO4	2	2	3	3	3	3	1	1	-	-	2	2
CO5	2	2	3	3	3	3	1	1	-	-	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this sessional

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	2	3	3	3	2	1	2	1	-	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

8TH SEMESTER

(PROFESSIONAL ELECTIVE-V)

FLUIDIZATION ENGINEERING (Code: BCMPE801)

Module-I (8 Hours)

Introduction: The phenomenon of fluidization; liquid like behaviour of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds.

Module-II (8 Hours)

Industrial applications of fluidized beds: Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization

Module-III (8 Hours)

Fluidization and mapping of regimes: Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization.

Module-IV (8 Hours)

Bubbles in dense bed: Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles. Bubbling Fluidized beds: Experimental findings; Estimation of bed porosities; Physical models: simple two phase model; K-L model. High velocity Fluidization: Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization.

Module-V (8 Hours)

Solids Movement, Mixing, Segregation and staging: Vertical movement of solids; Horizontal movement of solids; Staging of fluidized beds. Gas Dispersion and Gas interchange in Bubbling Beds: Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients. Particle to Gas Mass Transfer: Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

Text Books:

1. D. Kunii and O. Levenspiel, Fluidization Engineering.

Reference Books:

1. M. Leva, Fluidization.
2. J S M Botterill, Fluid bed heat transfer.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the knowledge of fluidization behaviour of various processes.
CO2	Recognise the pressure drop, bubble size, TDH, voidage, heat and mass transfer rates for the fluidized beds.
CO3	Describe model equations for fluidized beds.
CO4	Design the gas-solid fluidized bed reactors.
CO5	Apply the various fluidization regimes and can do the classification of particles.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	1	1	3	3	2	1
CO2	3	3	3	2	3	2	1	1	3	3	2	1
CO3	3	3	3	2	3	2	1	1	3	3	2	1
CO4	3	3	3	2	3	2	1	1	3	3	2	1
CO5	3	3	3	2	3	2	1	1	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	2	3	2	1	1	3	3	2	1

WASTE WATER MANAGEMENT (Code: BCMPE802)

Module-I (8 Hours)

Introduction to Sanitation: Systems of sanitation- relative merits and demerits - collection and conveyance of wastewater - Classification of sewerage Systems-Estimation of sewage flow and storm water drainage- Fluctuations-types of sewers- Hydraulics of sewers and storm drains design of sewers- Appurtenances in sewage- Cleaning and ventilation of sewers.

Module-II (8 Hours)

Pumping of wastewater: Pumping stations-location- components- Types of pumps and their suitability with regard to wastewaters. House Plumbing: Systems of plumbing-sanitary fittings and other accessories-one pipe and two pipe Systems-Design of building drainage.

Module-III (8 Hours)

Sewage characteristics: Sampling and analysis of waste Water-Physical, chemical and Biological Examination-Measurement of BOD & COD- BOD equations. Treatment of sewage: Primary treatment- Screens-grit chambers- grease traps- floatation Sedimentation-Design of preliminary and primary treatment units.

Module-IV (8 Hours)

Secondary treatment: Aerobic and anaerobic treatment process -comparison. Suspended growth process: Activated sludge process, principles, Design and operational problems, modifications of activated sludge processes, oxidation ponds, aerated lagoons. Attached Growth process: Trickling Filters-Mechanism of impurities Removal-Classification-Design -operation and maintenance problems; RBCs, Fluidized bed reactors.

Module-V (8 Hours)

Miscellaneous Treatment Methods: Nitrification, Removal of phosphates-UASB- Membrane reactors- Integrated fixed film reactors. Anaerobic Processes: Septic Tanks, Imhoff tanks-Working principles and Design-Disposal of septic tank effluent-FAB Reactors. Bio-solids (sludge) management**:** Characteristics- Handling and treatment of Sludge-Thickening-Anaerobic digestion of sludge. Disposal of sewage: Methods of disposal- Disposal into water bodies-Oxygen Sag Curve-Disposal into sea-disposal on land- Sewage sickness.

Text Books:

1. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw- Hill edition.
2. Elements of Environmental Engineering, K.N. Duggal, S.Chand& Company Ltd. NewDelhi, 2012.
3. Environmental Engineering, Howard S.Peavy, Donald R. Rowe, Teorge George
4. Tchobanoglous- Mc-Graw-Hill Book Company, New Delhi, 1985.
4. Wastewater Treatment for Pollution Control and Reuse, Soli. JAreivala, Sham R
5. Asolekar, Mc-GrawHill, New Delhi; 3rd Edition.
5. Industrial Water & Wastewater Management, KVSG MuraliKrishna.

Reference Books:

1. Environmental Engineering-II: Sewage disposal and Air Pollution Engineering, Garg, S.K, Khanna publishers.
2. Sewage Treatment and Disposal, Dr. P. N. Modi & Sethi.
3. Environmental Engineering, Ruth F. Weiner and Robin Matthews- 4thEdition Elsevier,2003.
4. Environmental Engineering, D. Srinivasan, PHI Learning Pvt., Ltd., New Delhi,2011

Course Outcomes:

Upon completion of the course the students will demonstrate the ability to:

CO1	Understand the outline planning and the design of wastewater collection, conveyance and treatment systems for a community/town/city.
CO2	Apply the characterization techniques of waste water generated in a community.
CO3	Analyse the impact of treatment of sewage and the need for its treatment.
CO4	Select the appropriate appurtenances in the sewerage systems.
CO5	Identify the critical point of pollution in a river for a specific amount of pollutant disposal into the river.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	3	1	2	-	-	3	1	2	1
CO2	1	2	-	3	1	2	-	-	3	1	2	1
CO3	1	2	-	3	1	2	-	-	3	1	2	1
CO4	1	2	-	3	1	2	-	-	3	1	2	1
CO5	1	2	-	3	1	2	-	-	3	1	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	2	-	3	1	2	-	-	3	1	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

COLLOID AND INTERFACE ENGINEERING (Code: BCMPE803)

Module-I (8 Hours)

General introduction of colloids, interfaces, surfactants, and micellization.; Intermolecular forces, Vander Waals forces (Keesom, Debye, and London interactions), Colloidal systems and colloidal stability (van der Waals attraction and potential energy curves), Brownian motion and Brownian flocculation. Surface and interfacial tension and surface free energy, Surface tension for curved interfaces, Surface excess and Gibbs equation.

Module-II (8 Hours)

Theory of surface tension and contact angle, and wetting, thermodynamics of interfaces, thermodynamics of micelle and mixed micellar formation.

Module-III (8 Hours)

Electrical phenomena at interfaces (Electro-kinetic phenomena, Electrical double layer). Emulsion and micro-emulsion

Module-IV (8 Hours)

General applications, Enhanced petroleum recovery, super hydrophobic and self-cleaning surfaces, novel fabrication of nano structured particles.

Module-V (8 Hours)

Measurement techniques of surface tension, Contact angle, Zeta-potential, Particle size.

Text Books:

1. P. C. Hiemenz, and R. Rajagopalan, Principle of colloid and surface chemistry, 3rd edition, Mercel Dekher, N. Y. 1997.
2. D. J. Shaw, Colloid & Surface Chemistry, Butterworth Heinemann, Oxford, 1992.

Reference Books:

1. M. J. Rosen, Surfactants and Interfacial Phenomena, Wiley-Interscience Publication, New York, 2004.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply knowledge of colloidal and interfacial phenomena.
CO2	Identify the colloidal suspensions, surface tension, wetting, surfactant adsorption, inter particle interactions, electro kinetics, and phenomena in biology.
CO3	Understand the concept of electrical phenomena at interfaces.
CO4	Apply the concept of surface chemistry.
CO5	Utilize their knowledge in various surface tension measurement techniques.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	1	2	3	-	2	1	3	1
CO2	3	2	1	-	1	2	3	-	2	1	3	1
CO3	3	2	1	-	1	2	3	-	2	1	3	1
CO4	3	2	1	-	1	2	3	-	2	1	3	1
CO5	3	2	1	-	1	2	3	-	2	1	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	1	-	1	2	3	-	2	1	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

CHEMICAL TECHNOLOGY-II (Code: BCMPE804)

Module-I (8 Hours)

Overview of Refinery Processes Crude Distillation Cracking Reforming and Isomerization Hydro Processing Alkylation Visbreaking and Coking

Module-II (8 Hours)

Gas processing and Polymerization, Refinery Supporting Processes

Module-3 (8 Hours)

Petrochemicals: Overview formaldehyde and chloro-methanes hydrocarbon steam cracking for petrochemicals vinyl chloride from ethylene ethylene oxide and ethanolamines isopropanol and acetone from propylene cumene and acrylonitrile from propylene. Isoprene and oxo-processing butadiene and benzene manufactures phenol from cumene and toluene phenol from benzene styrene and phthalic anhydride production.

Module-IV (8 Hours)

Manufacture of maleic anhydride and DDT industries, chemical recovery from black liquor manufacture of sugar from sugarcane, manufacture of ethanol from molasses soaps and detergents edible and essential oils coke production hydrogenation of coal.

Module-V (8 Hours)

Introduction to Food Technology, Food Processing, Polymer Manufacturing Processes.

Text Books:

1. W. L. Nelson, Petroleum Refinery Engineering.
2. B.K. BhaskaraRao, Modern Petroleum Refining Process, 6th Edition.

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Describe various manufacturing processes used in chemical process industries.
CO2	Understand major engineering problems encountered in chemical process industries.
CO3	Determine process aspects like yield, by-products formed, generation of waste.
CO4	Draw and explain process flow diagrams for a given process.
CO5	Solve any problems related to chemical process industries.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	3	1	-	2	3	-	1	-	2
CO2	1	2	-	3	1	-	2	3	-	1	-	2
CO3	1	2	-	3	1	-	2	3	-	1	-	2
CO4	1	2	-	3	1	-	2	3	-	1	-	2
CO5	1	2	-	3	1	-	2	3	-	1	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	2	-	3	1	-	2	3	-	1	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(PROFESSIONAL ELECTIVE-VI)

MODERN SEPARATION TECHNIQUES (Code: BCMPE805)

Module-I (5 Hours)

An overview of separation techniques. Surfactant based separation processes, Cloud-point extraction, Critical micellar concentration, Effect of various parameters, Mechanism of phase separation, Micellar enhanced ultra-filtration techniques: effect of various parameters, Liquid membranes: Mechanism and applications.

Module-II (10 Hours)

Membrane separations: Definition of a membrane and membrane process such as microfiltration, reverse osmosis, ultra-filtration, dialysis, electro dialysis, gas permeation, pervaporation Characterization of membrane such as colloidal morphology, permeability and perm-selectivity. Membrane modules such as: plate and frame device, spiral wound, tubular and hollow-fiber.

Module-III (10 Hours)

Supercritical Fluid Extraction: Critical Condition, supercritical (SC) solvents, Important parameters for SCF extraction, Advantages of SCF extraction, Mechanism of solubilisation of solutes from solid materials, Basic techniques in SCF technology, Applications of SC extraction. Electrophoretic separation methods: Fundamentals, Complicating factors in Electrophoresis, advantages, Zonal electrophoresis,

Module-IV (5 Hours)

Chromatography separation: Fundamentals of HPLC, chromatography column, Development of gradient-elution separations. Basic principles of capillary electro chromatography, mobile phase composition, Stationary phases used.

Module-V (10 Hours)

Solid separation processes: Physical properties of solids, classification of powders, particle size distributions, particle density, bulk density and porosity, forces of adhesion. Separation of particulates and powders. Wet separation process: Protein recovery, Soya processing and other applications. Centrifugal Separation processes.

Text Books:

1. J. D. Seader, and E. J. Henley, Separation process principles, John Wiley & Sons Inc, 1998.

Reference Books:

1. M.A. McHugh and V. J. Krukonis, Supercritical fluid extraction, Butterworths, Boston, 1985.

Course Outcomes: Upon completion of the course the students will demonstrate the ability to:

CO1	Select the suitable separation techniques used in chemical industries for a specific purpose.
CO2	Apply membrane separation processes for the water treatment.
CO3	Perform the extraction using Supercritical Fluid Extraction techniques.
CO4	Utilize the Chromatography separation process for the separation of organic products.
CO5	Choose the appropriate Solid separation processes for separating the solids from a mixture

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	3	2	2	-	1	3	2	-	1	2
CO2	1	-	3	2	2	-	1	3	2	-	1	2
CO3	1	-	3	2	2	-	1	3	2	-	1	2
CO4	1	-	3	2	2	-	1	3	2	-	1	2
CO5	1	-	3	2	2	-	1	3	2	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	-	3	2	2	-	1	3	2	-	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PROCESS INSTRUMENTATION (Code: BCMPE806)

Module-I (8 Hours)

Basic principles: Elements of instruments, Static characteristics, Dynamic characteristics, Applications of Laplace transforms in instruments, Responses of first & second order instruments and capacitance; Temperature measuring instruments like Bimetallic, Vapour pressure, Thermocouples, Automatic Potential Recorders, Resistance thermometers, Radiation pyrometers, Optical Pyrometers, Photo-electric Pyrometers, Thermistors, Responses of these instruments;

Module-II (8 Hours)

Composition measuring instruments: Spectroscopic methods, Thermal conductivity cells, Carbon dioxide analyser, Humidity measurement, Moisture in paper and lumber, pH meter, Oxygen analyser, polarograph, Refractometer, Chromatography, Colorimetry, Combustible gas analysers.

Module-III (8 Hours)

Measurement of pressure and vacuum: Manometers, Pressure spring, McLeod gauge, Pirani Gauge, Ionization Gauge, Thermocouple Gauge, Responses of these instruments, Measurement of flow properties: Viscosity and specific gravity measurement, Level measuring devices,

Module-IV (8 Hours)

Flow measuring devices, measurement of displacement; Biosensors and its applications, Process instrumentation diagram, Circular chart, Strip chart recorders, Electric transmission, Pneumatic transmission with examples.

Module-V (8 Hours)

Basic idea of automatic control and Instrumentation diagrams for equipment like distillation columns, evaporators, crystallisers, dryers and chemical reactors.

Text Books:

1. K. Krishnaswamy, Industrial Instrumentation, New Age Publishers, 2003

Reference Books:

1. J. Curtis, Process Control Instrumentation Technology, Prentice-Hallof India, 2005.
2. Donald P Eckman, Industrial Instrumentation, CBS Publisher

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Utilize their knowledge dynamic modelling and system behaviour study.
CO2	Understanding of dynamic modelling of a physical process using first principles.
CO3	Apply the knowledge of convert the model to a form amenable to solution and analysis.
CO4	Apply the knowledge for designing of controllers.
CO5	Utilize their knowledge in Knowledge of field instrumentations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	3	3	1	2	-	1	2	3	-
CO2	2	1	-	3	3	1	2	-	1	2	3	-
CO3	2	1	-	3	3	1	2	-	1	2	3	-
CO4	2	1	-	3	3	1	2	-	1	2	3	-
CO5	2	1	-	3	3	1	2	-	1	2	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	1	-	3	3	1	2	-	1	2	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

BIO-ENERGY ENGINEERING (Code: BCMPE807)

Module-I (6 Hours)

Introduction to bio-energy, road map of bio-energy technologies, World oil economy, unit of energy, Chemical composition, properties of biomass. Energy plantations. Size reduction, Briquetting, Drying, Storage and handling of biomass.

Module-II (8 Hours)

Basic biomass technology (resources and production), basics of mechanism of light reaction, exploration of photosynthesis process. In photosynthesis oxygen comes from the water molecule, Hill reaction, an electron transport process in light reaction, conversion of carbon dioxide into carbohydrate, From carbon dioxide to two Molecules of 3 - Phosphoglycerate by RUBISCO, RUBISCO enzyme, Photorespiration and calvin cycle, Efficiency calculation of photosynthesis process, C3 & C4 plant structure and photosynthesis process

Module-III (6 Hours)

Biomass production system and their categorization, Important parameters for selecting biomass crops, Factors determining the conversion process – I, Factors determining the conversion process – II, Factors determining the conversion process – III, Conversion technology, conversion process (Combustion process)

Module-IV (10 Hours)

Pyrolysis process classification of pyrolysis, Bio-oil (Solution for thermal instability and corrosiveness), Spark ignition engine and compression ignition engine, Carbonization - graphene like material

Module-V (10 Hours)

Introduction of Gasification, Thermo chemical process of gasification, Feedstock treatment of gasification, Feedstock property, Gasification Types: Up drift gasifier, Down drift and cross Flow gasifier, Operation and performance of fixed bed gasifier, fluidised bed gasification operation and performance of the fluidised bed gasifier.

Books:

1. Introduction to Bioenergy (Energy and the Environment) by Vaughn C. Nelson (Author),
2. Bioenergy: Biomass to Biofuels by Anju Dahiya

Course Outcomes: Upon completion of the subject the students will demonstrate the ability to:

CO1	Apply the fundamental knowledge in the field of bio-energy technology.
CO2	Develop a new biomass technology as future fuel.
CO3	Select the suitable operating parameters for biomass energy production.
CO4	Operate the biomass pyrolysis plant.
CO5	Design biomass pyrolysis and gasification plants.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	3	3	1	2	-	1	2	3	-
CO2	2	1	-	3	3	1	2	-	1	2	3	-
CO3	2	1	-	3	3	1	2	-	1	2	3	-
CO4	2	1	-	3	3	1	2	-	1	2	3	-
CO5	2	1	-	3	3	1	2	-	1	2	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	1	-	3	3	1	2	-	1	2	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

PROJECT ENGINEERING (Code: BCMPE808)

Module-I (8 Hours)

Introduction to the subject; Development and implementation of the project in the following steps: Initial conception; Preliminary design ideas and rough evaluation of market and economics; Procuring data for final design; Final economic evaluation and decision set up the project; Detailed design; Procurement; Construction work; Start up and trail runs; Commercial production; Safety consideration

Module-II (8 Hours)

Process Design; Selection of process cycle; Chemical process considerations; Qualitative block type process flow sheet; Material balance and energy balance

Module-III (8 Hours)

Selection of process equipment and its computer aided design using Fortran language to various engineering problems

Module-IV (8 Hours)

Plant layout: Planning layout and methods of layout planning; Economic evaluation of the project; Capital Cost; Plant cost estimating

Module-V (8 Hours)

Total product cost: Manufacturing cost; Raw material cost; Miscellaneous cost (labour cost, Repair cost and maintenance cost); Depreciation; Economic Analysis: Net earning profitability analysis; Introduction to optimization.

Text Books:

1. Peters – Timmerham (International Editions), Plant Design and Economics for ChemicalEngineers, McGraw Hill Book Co.

Reference Books

1. F. C. Viberandt and C. E. Dryden (International Students Editions), Chemical Engineering PlantDesign, McGraw Hill Book Co.
2. B. S. Golfried, Theory and Problems of Programming with Fortran: Schaum'sOutlineSeries, Tata McGraw Hill.

Course Outcomes: Upon completion of the course the students will demonstrate the ability to:

CO1	Understand project characteristics and various stages of a project.
CO2	Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
CO3	Analyse the learning and understand techniques for Project planning, scheduling and Execution Control.
CO4	Apply the risk management plan and analyse the role of stakeholders.
CO5	Understand the contract management, Project Procurement, Service level Agreements and productivity.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	2	1	-	2	1	3	2	-	1
CO2	3	1	-	2	1	-	2	1	3	2	-	1
CO3	3	1	-	2	1	-	2	1	3	2	-	1
CO4	3	1	-	2	1	-	2	1	3	2	-	1
CO5	3	1	-	2	1	-	2	1	3	2	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	1	-	2	1	-	2	1	3	2	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

(OPEN ELECTIVE-IV)

OPTIMIZATION TECHNIQUES (Code: BCMOE 801)

Module-I (8 Hours)

Optimal problem formulation, Single variable optimization algorithms including interval halving; golden section search; Newton-Raphson method; bisection method; root finding using optimization techniques, Multi variable optimization algorithms including simplex search method; Cauchy's steepest descent method; Levenberg Marquardt's method

Module-II (8 Hours)

Constrained optimization algorithms including Khun-Tucker conditions, transformation methods; direct search methods; liberalized search techniques; feasible direction method,

Module-III (8 Hours)

Specialized algorithms including integer programming; geometric programming.

Module-IV (8 Hours)

Non-traditional optimization techniques like simulated annealing, Application of the aforesaid techniques in Chemical Engineering designs like optimum insulation thickness.

Module-V (8 Hours)

Application of the aforesaid techniques in Chemical Engineering designs like shell and tube heat exchanger design**,** Software tools for optimization, solving of various optimization problems using excel software and MATLAB.

Text Books:

1. T. F. Edgar, D. M. Himmelblau, Optimization of Chemical Processes, Mcgraw-Hill College Division, 1987.

Reference Books:

2. B. V. Babu, Process Plant Simulation, OUP, India, 2004.
3. S. S. Rao, Engineering Optimization Theory & Practice, John Wiley & Sons Inc, 1996.

Course Outcomes: Upon completion of the course the students will demonstrate the ability to:

CO1	Identify different types of optimization problems
CO2	Understand different optimization techniques used in chemical industry
CO3	Solve various multivariable optimization problems
CO4	Solve optimization using MATLAB
CO5	Solve optimization using ASPEN HYSIS

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	2	1	1	2	1	2	1
CO2	3	2	2	1	2	2	1	1	2	1	2	1
CO3	3	2	2	1	2	2	1	1	2	1	2	1
CO4	3	2	2	1	2	2	1	1	2	1	2	1
CO5	3	2	2	1	2	2	1	1	2	1	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	1	2	2	1	1	2	1	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation