With effect from 2023-24

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (With effect from 2023-2024)

B.Tech (Chemical Engineering)

Semester VII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE inHours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1		**Professional Elective -IV**	3		-	3	40	60	3
		Open Elective - II	3	-	-	3	40	60	3
3		**Professional Elective – V**	3	-	-	3	40	60	3
4		Open Elective - III	3	-	-	3	40	60	3
5		Gender sensitization	2	-	-	2	0	50	NC
6	20CHI03	Internship	4-6 weeks / 180 hours						3
PRACTICAL									
8	20CHC24	Project Design Part I	-	-	4	-	50	50	2
TOTAL			**14**		**4**	**-**	**210**	**340**	**17**

	Course Code	**Professional Elective IV**
1	20CHE13	Biochemical Engineering
2	20CHE14	Corrosion Engineering
3	20CHE15	Optimization of Chemical Processes
4	20CHE16	Process Intensification

	Course Code	**Open Elective II**
1	20ME O01	Robotics
2	20EGO 01	Technical Writing Skills
3	20CSO 07	Basics of Machine Learning
4	20 IT O 01	Object Oriented Programmin Using JAVA

	Course Code	**Professional Elective V**
1	20CHE17	Computational Fluid Dynamics
2	20CHE18	Mineral Processing Technology
3	20CHE19	Nuclear Engineering
4	20CHE20	Sustainable Engineering

	Course Code	**Open Elective III**
1	20MEO03	Research Methodology
2	20EEO02	Energy Management Systems
3	20ITO02	Principles of IoT
4	20PYO01	Histories of Science and Technology

20CH E 13 **BIOCHEMICAL ENGINEERING**

(Professional Elective IV)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basics of biology, Mass Transfer, CRE

Course Objectives: This course helps the students to understand the functions of living cells

1. apply the principles of Chemical Engineering to bioprocesses.
2. conduct analysis on the biological factors that are important in the design, operation, performance and/or monitoring of a biological process
3. understand the significance of microbes and enzymes
4. understand the applications of different bioprocesses

Course Outcomes: On successful completion of this module, students should be able to

1. Describe the basic structure and function of cells & relate cell function to products and processes useful toman
2. Explain classification, growth concepts and various types of interactions in microbes
3. Illustrate the significance of enzymes as biocatalysts and immobilized enzymes.
4. Identify and explain the basic features of bioreactors
5. Describe the principles of the various separation procedures involved in the downstream processing of products
6. Summarize the principles of Fermentation technology and products from Industrial biotechnology

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	1	1
CO2	2	-	1	-	1	-	-	1	1	-	-	2	2	2
CO3	2	2	2	1	1	1	1	1	1	-	-	2	2	2
CO4	2	2	2	1	1	1	1	-	1	-	-	1	2	2
CO5	1	1	2	2	1	1	1	-	1	-	-	1	2	2
CO6	1	-	1	-	-	1	-	-	-	-	-	1	1	1

UNIT – I

Introduction to Biochemical Engineering, Molecular Biology& Bio Chemistry

Biochemical Engineering Principles, Biophysics and cell doctrine: Atomic Theory and Cell Theory, Important cell types, structure and functions of a typical cell and their components, Transport across cell membranes: Passive and facilitated diffusion, Active transport Structure and functions of Bio Molecules: Carbohydrates, lipids, Nucleotides to Nucleic Acids – RNA and DNA, Amino acids to Proteins - the building blocks of biochemical life Biosynthesis and Metabolic Pathways: Biosynthesis of Small and Macro Molecules Introduction of metabolic pathways and end products of glucose metabolism.

UNIT – II

Introductory Microbiology

Introduction to Microbiology: Classification and Industrial uses of Microorganisms Growth and Reproduction of Microbes: Growth cycle phases for batch cultivation. Monod's growth kinetics – Growth
Rate dependant classification of Microorganisms.
Microbial Genetics: Recombinant DNA technology and mutant populations. Multiple Interacting Microbial populations: Neutralism, Mutualism, Commensalism, Amesanalism, Predatism and Parasitism

UNIT – III

Enzyme Technology

Enzymology: Enzymes as Biocatalysts - The enzyme substrate complex and enzyme action and Classification of Enzymes based on Functions.
Kinetics of Enzyme Catalyzed Reactions: Simple enzyme kinetics with one and two substrates. Determination of rate constants, substrate activation and inhibition, modulation and regulation of enzyme activity / effect of PH and temp on enzyme activity.

Immobilized Enzyme Technology: Types of Enzyme immobilization, Immobilized enzymes in industrial processes,
Cofactors, Apo-enzymes and Coenzymes utilization and regeneration

UNIT – IV

Bioreactors and Down Stream Techniques - Introduction

Design and Analysis of Biological Reactors: Batch and Continuous Stirred Tank Reactors, Enzyme reactors Ideal Reactors for kinetic measurements: The ideal batch reactor / The ideal continuous flow stirred tank reactor - Alternate bio-reactor configurations

Separation Processes: Filtration, Centrifugation, Adsorption, Reverse osmosis, Dialysis, Electrophoresis, Sedimentation and Extraction Purification Processes: Precipitation, Crystallization, and Chromatography

UNIT – V

Bioprocess Technology

Fermentation Technology: Types of Fermentation, Medium formulation and Culture Propagation, Environmental Biotechnology: Effluent treatment.

Industrial Biotechnology: Commercial enzymes, Antibiotics and single cell protein

Text Books:

1. James, E Bailey and David F Ollis, "Biochemical Engineering fundamentals", 2nd Edition, McGraw-Hill InternalEdition.1986
2. Prof. Shigeo Katoh, Prof. Fumitake Yoshida, "Biochemical Engineering: A Textbook for Engineers, Chemists and Biologists", First Edition, Wiley- VCH Verlag GmbH & Co.2010

Suggested Reading:

1. Michael L Shuler and Fikret Kargi, "Bioprocess Engineering: Basic Concepts". Second Edition Prentice Hall, 2002

With effect from 2023-24

20CH E 14 **CORROSION ENGINEERING**
(Professional Elective IV)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: MEB, MUO, Chemical Technology

Course Objectives: This course will help the students:

1. Definition and classification of corrosion.
2. Principles of corrosion, common corrosion forms.
3. Different corrosion testing methods.
4. Corrosion control methods and material selection for cost reduction.
5. Modern theories to explain corrosion

Course Outcomes: At the completion of this course students will be able:

1. Explain and predict various corrosion mechanism based on the corrosion theories
2. Distinguish and identify various types of corrosion
3. Explain and apply corrosion testing methods
4. Identify and apply various corrosion prevention techniques
5. Apply modern theories and techniques to predict and prevent corrosion
6. Assess the role of corrosion protection for sustainable materials use.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	2	2	1	1	1	1	2	2	2
CO2	2	2	2	2	1	2	2	1	1	1	1	2	2	2
CO3	2	3	2	2	1	2	2	1	1	1	1	3	3	2
CO4	2	3	2	2	1	2	2	1	1	1	1	3	2	3
CO5	2	2	3	2	2	2	2	1	1	1	1	3	3	3
CO6	2	3	2	2	1	2	2	1	1	1	1	2	2	2

UNIT- I

Introduction: Corrosion principles, Types of Corrosion, Acid Theory, Dry chemical corrosion, Wet theory or Electrochemical Theory, Electro- chemical aspects of Corrosion, environmental effects, Pilling Bedworth Rule, Metallurgical aspects, corrosion rate expressions, methods of estimation of corrosion rates, Passivity.

UNIT- II

Types of corrosion: Forms of corrosion, uniform attack, galvanic corrosion, Examples of galvanic corrosion, Factors affecting galvanic corrosion, Crevice corrosion, Types of Crevice corrosion, pitting Corrosion: Principle and Theory, inter-granular corrosion, Knife line attack, selective leaching: Dezincification and Graphitization, Cavitation damage, Fretting Corrosion.

UNIT- III

Erosion-corrosion and some case studies, Factors affecting erosion- corrosion, stress corrosion cracking and Factors affecting stress corrosion.

Corrosion testing procedures: Introduction, Purpose of Testing, Steps involved in Corrosion testing, Standard expression for corrosion rate, NACE test, Slow stain rate test, Linear Polarization, Paint test, Seawater test, In vivo corrosion test (Field test).

UNIT- IV

Corrosion prevention methods: Protection against Corrosion: Material selection, alteration of environment, Use of inhibitors, Protection by proper Designing, Modification of the properties of the metal, Cathodic Protection and Anodic Protection Units, Use of protective coatings -organic and inorganic coatings, Methods of application of metallic coatings, cladding.

UNIT- V

Advanced techniques: Modern Theory: Principle, Thermodynamics: Free energy, Cell Potential, SHE and EMF series, Application of Thermodynamics to corrosion, Pourbaix Diagram. Electrode Kinetics: Exchange current density, Activation Polarization, Concentration Polarization, Combined Polarization, Mixed electrodes, Passivity with modern aspects. Predicting corrosion behaviour: Effect of oxidizers, Velocity effects, Galvanic coupling, Alloy evaluation. Corrosion prevention: Anodic Protection and Noble-Metal Alloying.

Text Books

1. Corrosion Engineering, 3rd ed., M G Fontana, Tata McGrawHill,2005.

Suggested Reading:

1. Corrosion and Corrosion Control, H H Uhlig, Wiley, 3rd edition,2011.
2. Handbook of Corrosion Engineering, Pierre Roberge, McGraw- Hill, New York,2000.

With effect from 2023-24

20 CHE15 **OPTIMIZATION OF CHEMICAL PROCESSES**

(Professional Elective IV)

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

Prerequisites: Mathematics, Mass Transfer, Plant Design and Economics

Course objectives: This course helps the students to

1. learn problem formulation of optimization,
2. realize the numerical methods of un-constrained optimization
3. learn linear programming and its applications

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

1. Formulate and analyze the elementary optimization problem.
2. Solve single variable optimization problems using different methods and can suggest a suitable technique for a given problem.
3. Solve multivariable optimization problems using various methods and can assess the suitability of those methods to a given problem.
4. Perform the optimization calculations of various unit operations.
5. Solve linear programming problems.

CO-PO-PSO MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	-	-	-	-	-	-	1	1	2	2
CO2	3	3	2	1	-	-	-	-	-	-	-	-	2	2
CO3	3	3	2	1	-	-	-	-	-	-	-	-	2	2
CO4	3	3	3	1	-	-	-	-	-	-	1	1	2	2
CO5	3	3	2	1	-	-	-	-	-	-	-	-	2	2

UNIT- I

Nature and organization of optimization problems: introduction to optimization scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

Basic concepts of optimization: Continuity of functions, unimodal versus Multi modal functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

UNIT- II

Optimization of unconstrained single variable functions: Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods - Sequential search. Methods specifying optimum by a point: Newton's method, Secant method, Quadratic interpolation. Applications of one dimensional search methods to chemical engineering problems.

UNIT- III

Unconstrained multivariable optimization: *Random search methods*: grid search, uni -variate search, multivariable Newton's method, steepest descent method, Conjugate search directions, Conjugate gradient method.

UNIT- IV

Optimization of Unit operations: Optimal pipe diameter, minimum work of compression, optimizing recovery of waste heat, optimization of multiple effect evaporator, shell and tube heat exchanger.

UNIT- V

Linear programming and applications: Basic concepts in linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, dual simplex method, revised simplex method.

Text Books:

1. Optimization of Chemical Processes, T.F. Edgar and D.M. Himmelblau, McGraw-Hill, New York, 2001.
2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000.

Reference Books:

1. S. S. Rao, Engineering Optimization Theory and Practice, 3rd edition, New Age International Publishers, India.

20 CHE16

PROCESS INTENSIFICATION
(Professional Elective IV)

Instruction	lours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

Prerequisites: Mass Transfer and CRE

Course objectives: This course helps the students to:

1. Understanding of the concept of Process Intensification.
2. Application of intensification techniques to a range of various separation processes.
3. Understanding of basic operating principles of a variety of intensified process.
4. Analyse the range of potential applications of intensified equipment.

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

1. Identify the scope for process intensification in chemical processes.
2. Implement methodologies for process intensification
3. Understand scale up issues in the chemical process.
4. Describe the impact of process intensification on heat transfer
5. Solve process challenges using intensification technologies.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	3	2	1	3	-	-	-	-	-	-	2	2
2	2	-	3	2	-	3	-	-	-	-	-	-	2	2
3	2	1	3	2	1	3	-	-	-	-	-	-	2	-
4	2	-	3	2	-	3	-	-	-	-	-	-	-	2
5	2	-	2	2	-	2	-	-	-	-	-	-	2	2

UNIT-I

Introduction: Techniques of Process Intensification (PI) Applications, The philosophy and opportunities of Process Intensification, Main benefits from process intensification, Process-Intensifying Equipment, Process intensification toolbox, Techniques for PI application.

UNIT-II

Process Intensification through micro reaction technology: Effect of miniaturization on unit operations and reactions, Batch to continuous reactions, Implementation of Micro reaction Technology, From basic Properties to Technical Design Rules, Inherent Process Restrictions in Miniaturized Devices and Their Potential Solutions, Micro fabrication of Reaction and unit operation Devices - Wet and Dry Etching Processes

UNIT-III

Scales of mixing, Flow patterns in reactors, mixing in stirred tanks: Scale up of mixing. Mixing in intensified equipment, Nebulizers, Ejectors, Tee mixers, Impinging jets, Rotor stator mixers, Design Principles of static Mixers Applications of static mixers, Higee reactors.

UNIT-IV

Combined chemical reactor heat exchangers and reactor separators: Principles of operation; Applications, Reactive absorption, Reactive distillation, Applications of RD Processes, Fundamentals of Process Modeling, Reactive Extraction Case Studies: Absorption of NO_x Coke Gas Purification.

UNIT-V

Enhanced fields: Energy based intensifications, Sono-chemistry, Basics of cavitation, Cavitation Reactors, Flow over a rotating surface, Hydrodynamic cavitation applications, Cavitation reactor design, Nusselt-flow model and mass transfer, The Rotating Electrolytic Cell, Microwaves, Electrostatic fields, Sono crystallization, Reactive separations, Supercritical fluids.

Text Books:

1. Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Process Intensification, Marcel Dekker, 2003.
2. Reay D., Ramshaw C., Harvey A., Process Intensification, Butterworth Heinemann, 2008.
3. Kamelia Boodhoo (Editor), Adam Harvey (Editor),Process Intensification Technologies for Green Chemistry: Engineering Solutions for Sustainable Chemical Processing, Wiley, 2013.

Reference books:

1. Segovia-Hernández, Juan Gabriel, Bonilla-Petriciolet, Adrián (Eds.)Process Intensification in Chemical Engineering Design Optimization and Control, Springer, 2016.
2. Reay, Ramshaw, Harvey, Process Intensification, Engineering for Efficiency, Sustainability and Flexibility, Butterworth-Heinemann, 2013

With effect from 2023-24

20 CH E17 **COMPUTATIONAL FLUID DYNAMICS**
(Professional Elective V)

Instruction	3 L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic knowledge of FM, HT, MTO, and Mathematics

Course Objectives: This course helps the students to understand the:

1. Recall the basic fluid and heat transfer governing equations
2. Utilize basic aspects of discretization for grid generation
3. Estimate fluid flow and heat transfer problems

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

1. Understand and select the governing equations of fluid flow and heat transfer
2. Enable to solve one and two-dimensional ordinary and partial differential equations using traditional CFD tools
3. Make use of discretization techniques for derivatives and differential equations to solve numerically
4. Examine general transformation equations for grid generation
5. Recommend suitable explicit, implicit and semi-implicit methods of finite difference scheme for given problems
6. Solve fluid flow field and temperature field to design any process equipment using some popular CFD techniques

CO-PO-PSO MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3	3	-	3	-	-	3	-	-	-	2	1
CO2	3	2	3	3	-	3	-	-	3	-	-	-	2	1
CO3	3	3	3	3	-	3	-	-	3	-	-	-	2	1
CO4	3	3	3	3	-	3	-	-	3	-	-	-	2	1
CO5	3	3	3	3	-	3	-	-	3	-	-	-	2	1
CO6	3	3	3	3	-	3	-	-	3	-	-	-	2	1

Unit-I

Overview of CFD: Introduction of CFD, Applications of CFD, Problem solving in CFD, Components of CFD Software. Comparison between numerical, analytical and experimental approaches, modeling versus experimentation

Unit-II

Principle of conservation: Fundamental principles of conservation, Reynolds transport theorem, conservation of mass, conservation of linear momentum: Navier-Stokes equation, conservation of energy, general scalar transport equation, turbulence modeling

Unit-III

Classification of Partial Differential Equations: Mathematical classification of partial differential Equation, physical and mathematical classifications of PDEs, systems of partial differential equations, Boundary value problems, boundary conditions,

Finite difference method: Discretization principles, truncation and round-off error, explicit and implicit approaches, basic of finite difference method, treatment of boundary conditions, finite difference applications in heat conduction and convection: solution of Navier-Stokes equation for incompressible flows using SIMPLE algorithm

Unit-IV

Finite Volume Method: Discretization methods, the four basic rules, one-dimensional steady and unsteady diffusion problems, two and three dimensional situations, convection and diffusion for one-dimensional steady problems, various discretization schemes.

Unit-V

Solution Algorithms and Techniques: LU decomposition, approximate factorization, Relaxation algorithms, Hybrid Schemes.**Grid Generation:** Structured Grid generation, Unstructured Grid generation, Adaptive Grid generation. **CFD Methods For Navier-Stokes Equations:** Beam-Warming algorithm, Mac Cormack's scheme, Upwind Techniques.

Text Books:

1. Computational Fluid Dynamics by J. D. Anderson, McGraw-Hill.
2. Computational Fluid Mechanics and Heat Transfer by J.C. Tannehill, D.A.Anderson, R.H. Pletcher, Taylor and Francis.
3. Computational Fluid Dynamics by T. J. Chung, Cambridge University Press

Reference text Books:

1. Numerical Heat Transfer and Fluid Flow, by Suhas V. Patankar
2. An Introduction to CFD by H K Versteeg and W. Malalasekera

With effect from 2023-24

20 CHE18 **MINERAL PROCESS TECHNOLOGY**

(Professional Elective V)

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: MUO

Course objectives:

1. Review all unit operations in mineral processing technology and the mineral concentration processes.
2. Introduce students to the importance and principles of materials handling in the mineral processing plant with special emphasis on feeding and conveying of bulk material.
3. Provide students the opportunities to acquire practical skills in concentrates handling, grade.
4. Determination, recovery and loss calculation and participatory laboratory experiments.

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

1. Understand the principles governing a range of processes applied in the mineral industry.
2. Describe typical unit processes and flow-sheets for production of a number of metals.
3. Apply basic engineering principles to the design of mineral processes.
4. Produce conceptual designs for simple extraction processes.
5. Understand the operation of beneficiation units for coal and mineral.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	-	2	-	-	-	-	-	-	-	-	2	2
2	2	2	-	2	-	2	-	-	-	-	-	-	2	-
3	3	-	-	2	-	1	-	-	-	2	-	-	-	2
4	2	2	-	-	-	1	-	-	-	-	-	-	2	2
5	-	-	-	2	-	-	2	-	2	-	1	1	2	-

UNIT – I

Introduction to Mineral Processing, Objectives, Scope and importance. Properties and Types of Minerals

Ore handling: removal of harmful materials - sampling of ores: moisture sampling, assay sampling, sampling Techniques, sample division methods.

UNIT – II

Mineral Liberation: Degree of liberation, concentration, measures of assessing metallurgical performance viz., Recovery, Ratio of Concentration, Grade, Enrichment ratio and

Recovery vs Grade

Laboratory sizing: Particle size and shape, Sieve analysis, Sub sieve techniques, centrifugal methods (warman cyclosizer), microscopic sizing, online particle size analysis.

UNIT – III

Classification: Principle of Classification, Types of Classifiers

Gravity concentration: Principle, Jigs, Basic Construction of Jig, Types of Jigs viz., Harz Jig, circular and radial jigs, coal jigs (Baum and Batac jigs)

Gravity concentration in streaming currents: Pinched sluice, cones, spirals, shaking table.

UNIT –IV

Heavy medial separation: Principle, liquids and suspension for heavy media separation.

Separation vessels : Gravitational vessels (Wemco Cone separator, Drum separator)

Centrifugal separators: (Vorsyl separator, LARCODEMS, Dyna whirlpool separator) DMS cyclone DMS circuits.

UNIT – V

Floatation – History and theory: Floatation practice: ore and pulp preparation, contact angle, work of adhesion; Floatation Reagents: collectors, frothers, regulators; and their action –reagents and conditioning- Flotation Machines: pneumatic (Davcra cell, flotation column, Jameson cell, froth separators) and mechanical (Denver cell, Wemco cell) electro flotation, skin flotation, **Case studies:**i) Advanced Beneficiation processes. ii) Different methods for fine particles collections (Copper, Iron, Au).

Text Book:

1. B.A.Wills – "Mineral Processing Technology " –7th edition Maxwell International Edition - 1987.

Suggested Reference Books:

1. Ashoka Gupta & Denis Yen, "Mineral Processing Design and Operations", 1st Edition, Elsevier Publishers.
2. S.K.Jain "Ore Processing" Oxford and TBHY Publishing Co. (P) Ltd., India (1986).
3. S. K. Jain, Ore Processing, Oxford- IBH Publishing Company, 2005.

With effect from 2023-24

20CHE19 **NUCLEAR ENGINEERING**

(Professional Elective V**)**

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Chemical Reaction Engineering I, Fluid Mechanics, Process Heat Transfer, Mechanical Unit Operations

Course Objectives: This course helps the students to understand:

1. fundamentals of nuclear fission reactions and products.
2. types of nuclear fuel materials, properties, characteristics.
3. nuclear fuel separation and enrichment methods along with flowsheets.
4. non-fuel materials required for design of the reactor structure, cladding and for moderation.
5. different types of reactors, concepts of heat removal, control and safety systems.
6. spent fuel management.

Course Outcomes: Upon completing this course, students will be able to:

1. identify the various radioactive elements based on the mechanism of fission process
2. processing and handling techniques for enrichment of fuel materials
3. properties and radiation effects of materials for design of cladding structure
4. fuel source, heat removal, control and safety needs for operation of nuclear reactors
5. design and working of fast breeder reactors
6. techniques practiced for handling, storage and reprocessing of spent fuel

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	1	-	-	-	2	-	1	-	-	-	-	2	-
CO2	-	1	2	2	1	2	1	1	-	-	-	-	2	-
CO3	1	1	-	-	-	2	-	1	-	-	-	-	2	-
CO4	-	1	1	-	-	2	-	1	-	-	-	-	2	-
CO5	-	1	2	2	1	-	1	1	-	-	-	-	2	2
CO6	1	1	2	2	-	-	-	1	-	-	-	-	2	1

UNIT – I

Nuclear fission: nuclear elements, radioactivity, radioactive nuclides and nuclear stability, isotopes of radioactive material, nuclear binding energy, radioactive decay - alpha decay, beta decay, gamma rays. Neutron reactions, fission cross-sections, fission rate and reactor power, prompt and delayed fission neutrons, fission products.

UNIT – II

Nuclear fuel materials: Types of fuel materials, properties and significant characteristics, fuel cycle, pre-reactor fuel operations, isotopic enrichment, isotopic separation requirements. Nuclear fuel utilization – breeding ratio, Uranium, Thorium and Plutonium utilization.

UNIT – III

Non-fuel reactor materials: Classification, mechanical properties, radiation effects of materials, corrosion of metals, structural and cladding materials, moderator and reflector materials.

UNIT – IV

Nuclear fission reactors: General features, classification, reactor development for power production. Design features, concepts of heat removal, control and safety systems for: pressurized water reactors (PWR), boiling water reactors (BWR). Heavy water moderated reactors (HWMR) and Fast breeder reactors (FBR).

UNIT – V

Spent fuel management: Characteristics of spent fuel, storage, disposal, reprocessing of spent fuel, Solvent extraction separation process, other possible separation processes.

Text Books:

1. Samuel Glasstone and Alexander Sesonske, "Nuclear Reactor Engineering", 3rd Ed, CBS Publishers and distributors, New Delhi, 1986.

Suggested reading:

1. Benjamin M. MA, "Nuclear reactor materials and applications", Van Nostrand Reinhold Co., New York, 1975.
2. John R. Lamarsh, "Introduction to Nuclear Engineering", Addison-Wesley publishing Co., Philippines, 1975.
3. Raymond L. Murray, "Nuclear Energy", Pergamon Press, New York, 1975.

With effect from 2023-24

20CH E 20 **SUSTAINABLE ENGINEERING**

(Professional Elective V**)**

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Environmental Science, Organic Chemistry

Course Objectives: This course will help the students:

1. To have an increased awareness on issues in areas of sustainability
2. To understand the role of engineering & technology within sustainable development
3. To know the methods, tools and incentives for sustainable product service system development
4. To establish a clear understanding of the role and impact of various aspects of engineering decisions on environmental, societal and economic problems.
5. To communicate results related to their research on sustainable engineering

Course Outcomes: At the completion of this course students will be able:

1. To relate sustainability concepts and ethical principles towards environment
2. To understand the different types of environmental pollution problems and their respect sustainable solutions.
3. To become aware of concepts, analytical methods/models, and resources for evaluating and comparing sustainability implications of engineering activities
4. To critically evaluate existing and new methods
5. To develop sustainable engineering solutions by applying methods and tools to research a specific system design
6. To apply concepts of sustainable development to address sustainability challenges in a global context.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3	1	1	2	3	2	1	1	1	3	2	2
CO2	2	2	3	2	1	2	3	2	1	1	1	3	2	2
CO3	2	1	3	1	2	2	3	2	1	2	1	3	2	2
CO4	3	1	3	3	1	3	3	2	2	1	1	3	2	3
CO5	3	3	3	1	2	2	3	2	1	1	2	3	3	3
CO6	3	2	3	2	1	2	3	2	2	1	1	3	3	2

UNIT- I

Introduction of sustainability- Need and concept of Sustainable Engineering, Social-environmental and economic sustainability concepts, Sustainable development and challenges, Environmental acts and protocols - Clean Development Mechanism (CDM).

UNIT- II

Economic and social factors affecting sustainability, Effects of pollution from natural sources, Solid waste-sources, impacts, 4R (Reduce, Reuse, Recycling, Recover) concept, Tools used to ensure sustainability in engineering activities such as environmental management systems and environmental impact assessment studies.

UNIT- III

Global, Regional and Local environmental issues, Carbon credits and Carbon trading, Carbon foot print, Environmental management standards, ISO 14000 series, Life cycle Analysis (LCA)-scope and goal, Procedures of EIA (Environment Impact Assessment) in India.

UNIT- IV

Basic concept of sustainable habitat-Sustainable cities, Sustainable transport, Sustainable sources of energy-conventional and renewable sources, Green Engineering: Green buildings, Green materials for sustainable design, Methods for increasing energy efficiencies of buildings.

UNIT- V

Technology and sustainable development, Sustainable urbanization, Social and Technological change, Industrial processes-material selection, Pollution prevention, Industrial ecology, Industrial symbiosis.

Text Books

1. Allen D. T and Shonnard D. R., Sustainability Engineering Concepts, Design and Case Studies, 1st Ed, Prentice Hall, 2011.
2. Bradley A. S, Adebayo A. O and Maria. P., Engineering Applications in Sustainable Design and Development, 1st Ed, Cengage Learning, 2016.

Suggested Reading:

1. Rag R. L., Introduction To Sustainble Engineering, 2nd Ed, PHI Learning Pvt Ltd, 2016.
2. Krishna R. Reddy, Claudio Cameselle, Jeffrey A. Adams., Sustainable Engineering,1st Ed, Wiley, 2019

With effect from 2023-24

20ME O01

ROBOTICS

(Open Elective II)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Principle of working of a robot, types and specifications, configuration, work envelops and motion controls and applications.
2. Transformations, kinematics and dynamics of robots.
3. Singularities, Jacobian and trajectory planning of a robot to prepare the robot for various tasks
4. Design of end effectors, drives, working of sensors and controllers for finding position and orientation.
5. Robot vision for image acquisition and processing and plan for various tasks and various Languages and Programming methods of robot.

Outcomes: At the end of the course, the students are able to

1. Describe the basic components, specifications and applications of the Robots.
2. Understand transformations, direct and inverse kinematics of robots.
3. Calculate forces in links and joints of a robot and find the singularities, Jacobian and trajectory planning of a robot for various tasks.
4. Classify drives, sensors and grippers for various applications.
5. Program a robot to predict motions for a given task with machine vision and sensors.

UNIT- I

Introduction to robotics: History and evolution of robots, basic configuration, degree of freedom, work envelope, motion control methods, various applications in industry, material handling, loading & unloading, processing, welding & painting, assembly, and inspection, requirements and specifications of robots.

UNIT- II

Rigid motions and homogeneous transformations: Rotation matrix, homogenous transformation matrix, Denavit- Hartenberg convention, Euler angles, RPY representation, direct and inverse kinematics for industrial robots for position and orientation.

UNIT- III

Velocity kinematics – the manipulator Jacobian: joint, end effect or velocity, direct and inverse velocity analysis. **Trajectory planning**: Interpolation, cubic polynomial, linear segments with parabolic blending, static force and moment transformation, solvability, stiffness, singularities.

UNIT- IV

Robot dynamics: Lagrangian Formulation for link inertia tensor and manipulator inertia tensor, Newton- Euler formulation for RR & RP manipulators.

Control: Individual, joint and computed torque.

UNIT -V

End effectors: Position and velocity measurement. **Sensors:** Proximity and range, tactile, force and torque,

Drives for Robots: Electrical, Hydraulic and Pneumatic.

Robot vision: Introduction to technique, image acquisition and processing, introduction to robot programming languages

Text Books:

1. Spong and Vidyasagar, Robot Dynamics and Control, John Wile and Sons,1990.
2. R.K. Mittal, I.J. Nagrath, Robotics and control, Tata Mcgraw-Hill Publishing Company Ltd., 2003.
3. Groover, Industrial Robotics, Mcgraw-Hill Publishing Company Ltd.2003.

Suggested Reading:

1. Asada and Slotine, Robot analysis and Intelligence, Wiley Interscience, 1986.
2. K.S. Fu GonZalezRC., lEEc.S.G., Robotics, Control Sensing Vision and Intelligence, McGraw Hill, Int.ed,1987.

20MEO03 **RESEARCH METHODOLOGIES**

(Open Elective III)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. To make the students to formulate the research problem.
2. To identify various sources for literature review and data collection.
3. To prepare the research design.
4. To equip the students with good methods to analyze the collected data.
5. To explain how to interpret the results and report writing.

Outcomes: At the end of the course, the students are able to

1. Define research problem.
2. Review and assess the quality of literature from various sources.
3. Understand and develop various sresearch designs.
4. Analyze problem by statistical techniques: ANOVA,F-test,Chi-square.
5. Improve the style and format of writing a report for technical paper/Journal report.

UNIT – I

Research methodology: Objectives and motivation of research, types of research- descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical, research approaches, significance of research, research methods vs. methodology, research process, criteria of good research, problems encountered by researchers in India, technique involved in defining a problem.

UNIT–II

Literature survey: Importance of literature survey, sources of information-primary, secondary, tertiary, assessment of quality of journals and articles, information through internet.

UNIT – III

Research design: Meaning of research design, need of research design, feature of a good design important concepts related to research design, different research designs, basic principles of experimental design, steps in sample design.

UNIT – IV

Data collection: Collection of primary data, Secondary data, measures of central tendency-mean, mode, median, measures of dispersion- range, mean deviation, standard deviation, measures of asymmetry (skewness), important parametric tests -z, t, F, Chi-Square, ANOVA significance.

UNIT – V

Research report formulation and presentation: Synopsis, dissertation, technical paper and journal paper, writing research grant proposal, making presentation with the use of visual aids, writing a proposal for research grant.

Text Books:

1. C.R Kothari, Research Methodology Methods & Technique, New Age International Publishers, 2004.
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011.
3. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand &Company Ltd., New Delhi, 2009.

Suggested Reading:

1. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.
2. Naval Bajjai, Business Research Methods, Pearson Education, 2011.

20 EEO02 **ENERGY MANAGEMENT SYSTEM**
(Open Elective III)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites:
Students should have prior knowledge on different energy generation systems, basic idea about audit instruments

Course Objectives:
1. To know the concept of Energy Management.
2. To understand the formulation of efficiency for various Engineering Systems
3. To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding Energy Management

Course Outcomes: After completion of this course, students will be able to:
1. Know the current Energy Scenario and importance of Energy Conservation.
2. Understand the concepts of Energy Management, Energy Auditing.
3. Interpret the Energy Management methodology, Energy security and Energy Strategy.
4. Identify the importance of Energy Efficiency for Engineers and explore the methods of improving Energy Efficiency in mechanical systems, Electrical Engineering systems
5. Illustrate the Energy Efficient Technologies in Civil and Chemical engineering systems

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	1	-	1	2	1	-	-	-	1	-	-	-
CO2	2	1	1	1	-	1	2	1	-	-	-	1	-	-	-
CO3	2	2	2	1	-	1	2	1	-	-	-	1	-	-	-
CO4	2	2	1	2	2	1	2	1	-	-	-	1	-	-	-
CO5	1	1	2	1	1	1	2	2	-	-	-	1	-	-	-

UNIT-I

Various form of Energy and its features: Electricity generation methods using different energy sources such as Solar energy, wind energy, Bio-mass energy, and Chemical energy such as fuel cells. Energy Scenario in India, Impact of Energy on economy, development, and environment sectors of national and international perspective.

UNIT-II

Energy Management-I: Defining Energy Management, need for Energy Management, Energy management techniques, importance of Energy Management, managing the Energy consumption, Energy Audit and Types, Energy Audit Instruments

UNIT-III

Energy Management-II: understanding Energy costs, bench marking, Energy performance, matchingenergy use to requirement, optimizing the input, fuel & Energy substitution, material and Energy balancediagrams,Energypricing,EnergyandEnvironment,EnergySecurity,

UNIT-IV

Energy Efficient Technologies I: Importance of Energy Efficiency for Engineers, Energy Efficient Technology in Mechanical engineering: Compressed Air System, Heating, ventilation and air-conditioning, Fans and blowers, Pumps and Pumping Systems,

Energy Efficient Technology in Electrical engineering: Automatic Power Factor Controllers, Energy Efficient Motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, space cooling, energy efficiency of lifts and escalator, energy saving potential of each technology.

UNIT-V

Energy Efficient Technologies-II: Energy Efficient Technology in Civil Engineering: Intelligent Buildings, And Various Energy Efficiency Rating Systems for Buildings, Green Buildings Energy Efficiency: management of green buildings, importance of embodied energy in selection of sustainable materials, green building design, waste reduction/recycling, rain water harvesting, maintenance of the green buildings, green building certification, Renewable energy applications**.**

Energy Efficient Technology in Chemical Engineering: Green chemistry, Low carbon cements, recycling paper.

Text books:

1. Umesh Rathore,'Energy Management', Kataria publications, 2nd editon, 2014.
2. G Hariharaiyer,"Green Building Fundamentals", Notion press.com
3. K V Shama, P Venkataseshaiah, "Energy management and conservation", I.K. International Publishing agency pvt. ltd., 2011, ISBN:978-93-81141-29-8

SuggestedReading:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1,General Aspects
2. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queens land University of Technology.
3. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

With effect from 2023-24

20 PY O01 **HISTORIES OF SCIENCE AND TECHNOLOGY**

(Open Elective III)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of the course is to make the student

1. Gains the knowledge about origin of science in the Stone Age and its progress during Antiquity period.
2. Familiar with scientific views in the Medieval period and during the Industrial revolution. .
3. Aware of modern scientific developments from 19th century onwards.

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

1. Demonstrate the process of beginning of science and civilization, knowledge acquisition and philosophical approach of science and its advancements in the Stone Ages and Antiquity period.
2. Illustrate the advancements in science and technology in the medieval period across Asia and Arab countries and decline and revival of science in Europe.
3. Explain the scientific approach and its advances of the Europeans and how the role of engineer during the industrial revolution and the major advancements.
4. Make use of the advancements in the field of science and technology by adopting new philosophies of 19th and first half of 20th century in finding ethical solutions to the societal problems.
5. Interpret the changes in specializations of science and the technology and build the relation between information and society from second half of 20th century onwards.

UNIT-I

Science - The Beginning (through 599 BCE): The Stone Ages, Knowledge among hunter gatherers, Agricultural Revolution and other revolutions, Civilization, Major advances.

Science in Antiquity (600 BCE - 529 CE): Philosophy- a precursor to science, Hellenistic world and the Roman Empire, Other cultures of the period, Major advances.

UNIT-II

Medieval Science (530 CE - 1452 CE): The decline of science in Europe, Science in China, Science and mathematics in India, Arab science, Revival of science in Europe, Technology revolution of the Middle ages, Major advances.

The Renaissance and the Scientific Revolution (1453 CE – 1659 CE): Renaissance, Scientific Revolution, Technology, Major advances.

UNIT-III

Scientific Method: Measurement and Communication (1660 CE – 1734 CE): European domination, The scientific method, Major advances.

The Industrial Revolution (1735 CE – 1819 CE): Industrial Revolution, Rise of the engineer, Major Advances.

UNIT-IV

Science and Technology in the 19th Century (1820 CE – 1894 CE): Philosophical basis of 19th-century science, Science and the public, Science and technology, Major advances.

Rise of Modern Science and Technology (1895 CE – 1945 CE): The growth of 20thcentury science, New philosophies, Quantum reality, Energy sources, Electricity: a revolution in technology, Major advances.

UNIT-V

Big Science and the Post-Industrial Society (1946 CE – 1972 CE): Big science, Specialization and changing categories, Technology changes society, Major advances.

The Information Age (1973 CE – 2015 CE): Information and society, Globalization, The post-industrial society, Problems of the Information age, Major Advances

Text Books:

1. Bryan Bunch and Alexander Hellemans, "The History of Science and Technology", Houghton Mifflin Company (New York), 2004
2. JD Bernal, "Science in History", 4 Volumes, Eklavya Publishers, 2012

Suggested Readings:

1. "The 100 Most Influential Scientists of All Time", Edited by Kara Rogers, Britannica Educational Publishing, 2010
2. Alberto Hernandez, "A Visual History of Science and Technology", The Rosen Publishing Group, 2016

20EG M 04 **GENDER SENSITIZATION**

Instruction	2L Hours per week
Duration of SEE Examination	2 Hours
SEE Examination	50 Marks
CIE	0 Marks
Credits	0

Course Objectives: This course will introduce the students to

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

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

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

UNIT – I
Understanding Gender:
Gender: Why Should We Study It? (*Towards a World of Equals*: Unit -1)
Socialization: Making Women, Making Men (*Towards a World of Equals*: Unit -2)
Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

UNIT – II
Gender And Biology:
Missing Women: Sex Selection and Its Consequences (*Towards a World of Equals*: Unit -4)
Declining Sex Ratio. Demographic Consequences.
Gender Spectrum: Beyond the Binary (*Towards a World of Equals*: Unit -10)
Two or Many? Struggles with Discrimination.

UNIT – III
Gender and Labour:
Housework: the Invisible Labour (*Towards a World of Equals*: Unit -3)
"My Mother doesn't Work." "Share the Load."
Women's Work: Its Politics and Economics (*Towards a World of Equals*: Unit -7)
Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

UNIT-IV
Issues Of Violence
Sexual Harassment: Say No! (*Towards a World of Equals*: Unit -6)
Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: "*Chupulu".*
Domestic Violence: Speaking Out (*Towards a World of Equals*: Unit -8)
Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading:

New Forums for Justice.
Thinking about Sexual Violence (*Towards a World of Equals*: Unit -11)
Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

UNIT – V
Gender: Co - Existence
Just Relationships: Being Together as Equals (*Towards a World of Equals*: Unit -12)
Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers.
Additional Reading: Rosa Parks-The Brave Heart.

Textbook:

1. A. Suneetha, Uma Bhrugubanda, DuggiralaVasanta, Rama Melkote,VasudhaNagaraj, AsmaRasheed, GoguShyamala, DeepaSreenivas and Susie Tharu **"Towards a World of Equals: A Bilingual Textbook on Gender"** published by Telugu Akademi, Hyderabad,Telangana State, **2015**.

Suggested Reading:

1. Menon, Nivedita. Seeing like a Feminist. New Delhi: Zubaan-Penguin Books, 2012
2. Abdulali Sohaila. **"I Fought For My Life…and Won."**Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

Web Resources:

1. https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction
2. https://theconversation.com/achieving-gender-equality-in-india

Note: Since it is an Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

With effect from 2023-24

20CHC24 **PROJECT: PART I**

Instruction	4P Hours per week
SEE	50 Marks
CIE	50 Marks
Credits	2

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

1. Summarize the literature review to identify and formulate engineering problems
2. Design the experiments/ process /mathematical model by selecting the engineering tools/components for solving the identified problem
3. Develop skills of problem solving, interpreting analysis and evaluation
4. Illustrate written and oral communication skills through project report and presentation
5. Demonstrate the knowledge, skills, attitude and ethics of a professional engineering graduate
6. Adapt to the working environment of Industry/Institute by working as a team

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1	2	2	1	1	1	1	2	2	2
CO2	2	3	3	3	1	2	2	1	1	1	1	2	2	2
CO3	3	3	2	3	2	2	2	1	1	3	1	2	3	2
CO4	2	3	2	2	1	2	2	1	1	1	1	2	2	3
CO5	2	1	1	1	1	2	1	3	2	2	1	2	3	3
CO6	1	1	1	1	1	1	1	2	3	2	2	2	2	2

The objective of Project Part -1 is to enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D.

The work shall include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility;
4. Preparing a Written Report on the Study conducted for Presentation to the Department;
5. Final Seminar, as oral Presentation before departmental committee.

Guidelines for the award of marks in CIE: (Max. Marks: 50)

Evaluation by	Max Marks	Evaluation criteria/parameter
Supervisor	20	Project status/review
	5	Report
Department committee	5	Relevance of the topic
	5	PPT preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

Guidelines for the award of marks in SEE: (Max. Marks: 50)

Evaluation by	Max Marks	Evaluation criteria/parameter
Supervisor External and Internal Examiners together	10	Power point presentation
	20	Thesis evaluation
	10	Innovations Applications Scope for future study
	10	Viva-Voce

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (With effect from 2022-2023)

B.Tech (Chemical Engineering)

Semester VIII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE inHours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1		Open Elective -IV	3		-	3	40	60	3
PRACTICAL									
1	20CHC25	Technical Seminar	-	-	2				1
2	20CHC26	Project Part II	-	-	8*				4
TOTAL			**03**		**10**	**-**			**8**
*180 hrs for the students working on the paid internship during VIII SEM Clock Hours per week : 20									

	Course Code	**Open Elective IV**
1	20ME O04	Principles of Entrepreneurship
2	20 EC O03	Principles of Biomedical Instrumentation
3	20EE O04	Waste management
4	20ADO03	Fundamentals of Data Science

20EC O03 **PRINCIPLES OF BIOMEDICAL INSTRUMENTATION**

(Open Elective IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge about human body and measurement concepts are required

Course Objectives: This course aims to:

1. To understand the physiological systems, present in the human body.
2. To understand the application of electronic systems used in modern healthcare.
3. To acquire, process and analyses Bio medical signals.

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

1. Describe the physiological, physical and chemical background of the most common bioelectrical phenomena.
2. Understand the electrode theory, different types of electrodes and transducers required to detect bioelectric signals.
3. Elucidate cardiovascular system, human assist devices and other physiological measurements.
4. Analyze and compare the different medical imaging systems using computers.
5. Explain patient monitoring systems through bio-telemetry and realize safety requirements of biomedical instrumentation.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	02	02	02	02	01	02	-	-	-	-	-	02	03	02	02
CO2	02	03	03	03	01	02	-	-	-	-	-	02	03	02	02
CO3	02	03	03	03	02	02	-	-	-	-	-	02	03	03	02
CO4	02	03	03	03	03	02	-	-	-	-	-	02	03	03	02
CO5	02	03	03	03	03	02	-	-	-	-	-	02	03	03	02

UNIT-I

Introduction to Bio Medical Instrumentation: Components of the Man-Instrument system, Physiological systems of the body, Problems encountered in measuring a living system. Sources of Bio electric potentials: Resting and action potentials, propagation of action potentials, Bio electric potentials.

UNIT-II

Basic Transducer Principles: Transducer principles, active and passive transducers, their bio medical applications.
Electrodes: Electrode theory, bio potential electrodes, bio chemical transducers.

UNIT-III

Cardiovascular System: The heart and cardiovascular system, the heart, blood pressure, blood flow, heart sounds, ECG, Measurement of blood pressure, blood flow, cardiac output, and heart sounds and PCG. Patient care and monitoring systems: Elements of Intensive care systems, patient monitoring systems, other instruments, organization of the hospital for patient care monitoring, pace makers, defibrillators.

UNIT-IV

Bio Medical Amplifiers: Basic requirements, differential amplifier, carrier amplifier, chopper amplifier, phase sensitive detector. EEG: Signal sources, EEG recording, applications of EEG. EMG: Surface and needle electrodes, EMG, measurement of conduction velocity, ERG and EOG

UNIT-V

Bio telemetry: Introduction, physiological parameters adaptable to biotelemetry, components of telemetry system, implantable units, applications of telemetry in patient care. Computer in Biomedical instrumentation: digital computer, microprocessor, interfacing computer with other medical equipment, biomedical computer applications, Introduction to CAT scanner. X-Ray: X-ray unit, radiation therapy, Introduction to MRI.

Text Books:

1. Leslie Cromwell, Fred J Weibell and Erich A.P Feiffer, 'Bio Medical Instrumentation and Measurements', PHI, 2nd edition, 2003.
2. C Raja Rao and SK Guha, 'Principles of Medical Electronics and Bio Medical Instrumentation', Universities press,2013.

Suggested Reading:

1. R.S Khandpur, 'Handbook of Biomedical Instrumentation', McGraw-Hill Education, 3rd edition, 2014
2. Andrew G. Webb, 'Principles of Biomedical Instrumentation', Cambridge University Press, 2017

With effect from 2023-24

20ME O04 **PRINCIPLES OF ENTREPRENEURSHIP**

(Open Elective IV)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Concept and procedure of idea generation.
2. The nature of industry and related opportunities and challenges.
3. Elements of business plan and it s procedure.
4. Project management and its techniques.
5. Behavioural issues and Time management.

Outcomes: At the end of the course, the students are able to

1. Understand the concept and essence of entrepreneurship.
2. Identify business opportunities and nature of enterprise.
3. Analyze the feasibility of new business plan.
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects.
5. Use behavioral, leadership and time management aspects in entrepreneurial journey

UNIT-I

Entrepreneurship: Definition, functions of entrepreneurship, qualities of entrepreneurs, identification and characteristics of entrepreneurs, entrepreneur vs. intrapreneur, first generation entrepreneurs, women entrepreneurs, conception and evaluation of ideas and their sources.

UNIT-II

Indian industrial environment: Competence, opportunities and challenges, entrepreneurship and economic growth, small scale industry in India, objectives, linkage among small, medium and heavy industries, types of enterprises, corporate social responsibility.

UNIT-III

Business plan: Introduction, elements of business plan and its salient features, business model canvas, technical analysis, profitability and financial analysis, marketing analysis, feasibility studies, executive summary, selection of technology and collaborative interactions.

UNIT-IV

Project management: During construction phase, project organization, project planning and control using CPM, PERT techniques, human aspects of project management, assessment of tax burden.

UNIT-V

Behavioral aspects of entrepreneurs: Personality, determinants, attributes and models, leadership concepts and models, values and attitudes, motivation aspects, time management: approaches of time management, their strengths and weaknesses. time management matrix and the urgency addiction .

Text Books:

1. Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 1997.
2. Prasanna Chandra, Project-Planning, Analysis, Selection, Implementation and Review, Tata Mcgraw- Hill Publishing Company Ltd, 1995.
3. S.S. Khanka, Entrepreneurial Development, S. Chand & Co. Pvt. Ltd., New Delhi, 2015.

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, Entrepreneurship, 5th edition, Tata Mc Graw Hill Publishing Company Ltd., 2005.
2. Stephen R. Covey and A. Roger Merrill, First Things First, Simon and Schuster Publication,1994.

20EE O04 **WASTE MANAGEMENT**
(Open Elective IV)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Course Objectives:

1. To Imbibe the concept of effective utilization of any scrap
2. To become familiar with the processes of all disciplines of engineering.
3. To learn the technique of connectivity from waste to utility.

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

1. Categorize the waste based on the physical and chemical properties.
2. Explain the Hazardous Waste Management and Treatment process.
3. Illustrate the Environmental Risk Assessment, methods, mitigation and control.
4. Interpret the Biological Treatment of Solid and Hazardous Waste.
5. Identify the waste disposal options, describe the design and construction, Operation, Monitoring, Closure of Land fills

CO-PO-PSO Matrix

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO3
CO1	1	1	1	-	-	1	2	1	-	-	-	1	1	-	-
CO2	1	2	2	1	1	2	2	1	-	-	-	1	1	-	-
CO3	2	2	2	2	1	2	2	2	-	-	-	1	1	-	-
CO4	1	1	1	1	1	1	1	1	-	-	-	1	1	-	-
CO5	1	2	2	2	1	2	2	2	-	-	-	1	1	-	-

UNIT-I

Introduction to waste management and Municipal Solid Waste Management: Classification of waste: Agro based, Forest residue, Industrial waste, e-Waste, Municipal Solid Waste Management: Fundamentals Sources, composition, generation rates, collection of waste, separation, transfer and transport of waste, treatment and disposal options.

UNIT-II

Hazardous Waste Management and Treatment: Hazardous Waste Identification and Classification, Hazardous Waste Management: Generation, Storage and collection, Transfer and transport, Processing, Disposal, Hazardous Waste Treatment: Physical and Chemical treatment, Thermal treatment, Biological treatment, Pollution Prevention and Waste Minimisation, Hazardous Wastes Management in India.

UNIT-III

Environmental Risk Assessment: Defining risk and environmental risk, Parameters for toxicity quantification, Types of exposure, Biomagnifications, Effects of exposure to toxic chemicals, risk analysis and risk matrix, method so frisk assessment, mitigation and control of the risk, case studies.

UNIT-IV

Biological Treatment: Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation.

UNIT-V

Waste Disposal: Key Issues in Waste Disposal, Disposal Options and Selection Criteria: Disposal options, Selection criteria, Sanitary Landfill: Principle, Land fill processes, Land fill Gas Emission: Composition and properties, Hazards, Migration, Control, Leachate Formation: Composition and properties. Leachate migration, Control, Treatment, Environmental Effects of Landfill, Landfill Operation Issues, Design and construction, Operation, Monitoring, Closure of Landfills-Landfill Remediation, national and International Waste management programs

Textbooks:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. La Grega, M.D. Buckingham, P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York,1994
3. RichardJ.Watts,HazardousWastes-Sources,Pathways,ReceptorsJohnWileyandSons,NewYork,1997

Suggested Reading:

1. Basics of Solid and Hazardous Waste Mgmt.Tech.by KantiL.Shah1999, Prentice Hall.
2. Solid and Hazardous Waste Management 2007byS.C.Bhatia Atlantic Publishers & Dist.

20CHC25 **TECHNICAL SEMINAR**

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

Course Objective:
The goal of a seminar is to introduce students to critical reading, understanding, summarizing, explaining and preparing report on state of the art topics in a broad area of his/her specialization. Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

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

1. Summarize the literature review in order to identify and formulate the engineering problem.
2. Show preparedness to study independently and apply acquired technical skills to variety of real time problem scenarios.
3. Develop the required critical thinking ability and analytical skills for evaluation of the selected problem.
4. Illustrate the written and oral communication skills through a seminar report and presentation.
5. Demonstrate the required knowledge, skills, attitude and ethics as a professional engineering graduate.
6. Work in a team by adapting to the working environment.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	-	3	2	3	3	3	2
CO2	1	2	2	2	1	1	-	-	3	2	3	3	3	2
CO3	2	2	2	2	1	1	-	-	3	2	3	3	3	2
CO4	3	2	2	2	1	1	-	-	3	2	3	3	3	2
CO5	3	2	2	2	1	1	-	-	3	2	3	3	3	2
CO6	3	2	2	2	1	1	-	-	3	2	3	3	3	2

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the department.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule shall be discouraged. For the award of sessional marks students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Note: Topic of the seminar shall be preferably from any peer reviewed recent journal publications

Guidelines for awarding marks		
S.No.	**Description**	**Max .marks**
1	Contents and relevance	**10**
2	Presentation skills	**10**
3	Preparation of PPT slides	**5**
4	Questions and answers	**5**
5	Report in a prescribed format	**20**

With effect from 2023-24

20CH C 26 **PROJECT: PART II**

Instruction	4P Hours per week
SEE	100 Marks
CIE	100 Marks
Credits	4

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

1. Summarize the literature review to identify and formulate engineering problems
2. Design the experiments/ process /mathematical model by selecting the engineering tools/components for solving the identified problem
3. Develop skills of problem solving, interpreting analysis and evaluation
4. Illustrate written and oral communication skills through project report and presentation
5. Demonstrate the knowledge, skills, attitude and ethics of a professional engineering graduate
6. Adapt to the working environment of Industry/Institute by working as a team

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1	2	2	1	1	1	1	2	2	2
CO2	2	3	3	3	1	2	2	1	1	1	1	2	2	2
CO3	3	3	2	3	2	2	2	1	1	3	1	2	3	2
CO4	2	3	2	2	1	2	2	1	1	1	1	2	2	3
CO5	2	1	1	1	1	2	1	3	2	2	1	2	3	3
CO6	1	1	1	1	1	1	1	2	3	2	2	2	2	2

The object of 'Project: Part-2' is to enable the student extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/ Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before Departmental Committee

Guidelines for the award of marks in CIE: (Max. Marks: 100)

Evaluation by	Max Marks	Evaluation criteria/parameter
Department committee	10	Review I
	15	Review II
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

Guidelines for the award of marks in SEE: (Max. Marks: 100)

Evaluation by	Max Marks	Evaluation criteria/parameter
External and Internal Examiners together	20	Power point presentation
	40	Thesis evaluation
	20	• Quality of the project • Innovations • Applications • Live Research Projects • Scope for future study • Application to society
	20	Viva-Voce