CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Scheme of Instructions of VII Semester of B.Tech. – Chemical Engineering as per AICTE Model Curriculum 2021-22

DEPARTMENT OF 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 in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
	THEORY								
1	18CH C 21	Transport Phenomena	3	1	-	3	30	70	4
2	18CH C 22	Process Technology and Economics	3	-	-	3	30	70	3
3	18CH C 23	Process Instrumentation	2	-	-	2	20	50	2
4		Core Elective V	3	-	-	3	30	70	3
5		Open Elective II	3	-	-	3	30	70	3
	PRACTICALS								
6	18CH C 24	Process Instrumentation and Control lab	-	-	3	3	25	50	1.5
7	18CH C 25	Process Modeling and Simulation lab	-	-	3	3	25	50	1.5
8	18CH C 26	Project: Part I	-	-	4	-	50	-	2
Total			**14**	**1**	**10**	**-**	**240**	**430**	**20**

L: Lecture T:Tutorial D:Drawing P: Practical

CIE – Continuous Internal Evaluation SEE- Semester End Examination

Core Elective V	
18CH E 13	Mineral Processing Technology
18CH E 14	Corrosion Engineering
18CH E 15	Scale-up Methods

Open Elective II	
18ME O 11	Modern Manufacturing Processes
18EE O 02	Energy Management Systems
18ME O 03	Research Methodologies
18CE O 02	Disaster Mitigation and Management
18CS O 10	Machine Learning using Python

18CH C 21 **TRANSPORT PHENOMENA**

Instruction	3L + 1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course introduces the students to

1. Fundamentals to solve flow problems involving transport of momentum, mass and energy using a unified approach
2. The analogy between momentum, mass and energy transport
3. The common mathematical structure of transport problems
4. The turbulent phenomena and the methods of characterizing the turbulent fluxes
5. Equations of change for isothermal and non-isothermal systems and multi-component mixtures

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

1. Develop expressions for velocity, temperature and concentration profiles using shell balances
2. Identify analogy between momentum, mass and energy transport
3. Formulate and solve one-dimensional transport problems by using the conservation equations
4. Apply equations of change to solve flow problems
5. Understand transport phenomena in turbulent flows

UNIT – I

Introduction - Mechanism of molecular transport of momentum, heat and Mass Transfer. Flux equations - Newton's, Fouriers' and Fick's laws - Similarities and differences

Non-Newtonian fluids, transport properties - estimation, temperature and pressure dependence, estimation of transport properties of binary gaseous mixtures

Velocity distributions in laminar flow - shell momentum balances - Flow of falling film - flow of fluids through circular tubes, annulus and Immiscible fluids between parallel plates.

UNIT – II

Temperature distributions in solids and in laminar flow – shell balances - Heat conduction with electrical, Nuclear, viscous and chemical heat source

Heat conduction through composite walls, and cooling fin; Forced convection and free convection

UNIT – III

Concentration distributions in solids and in laminar flow - shell mass balances, diffusion through a stagnant gas film, Diffusion with homogenous chemical reaction and heterogeneous chemical reaction. Diffusion into a falling liquid film-chemical reaction inside a porous catalyst

UNIT – IV

Equations of change for isothermal systems – Equation of continuity, Equation of Motion, Equations of change in curvilinear coordinates, use of equations of change to set up steady flow problems. Equations of change for non-isothermal systems – Equation of energy – use of equations of change to set up steady state flow problems. Equation of change for a binary mixture – Equation of continuity of a component in curvilinear coordinates

UNIT – V

Unsteady state problems in momentum, energy and Mass Transfer operations; Turbulence -Introduction to Time smoothing; Eddy properties - Intensity of turbulence Reynolds stresses; Semi empirical expressions for turbulent - momentum , energy and mass fluxes

Text Books:

1. R B Bird, W E Stewart, and E N Lightfoot , Transport Phenomena, John Wiley &Sons, 1960
2. R B Bird, W E Stewart, and E N Lightfoot, Transport Phenomena, Revised 2nd Edition, John Wiley & Sons Inc., 2007

Suggested Reading:

1. R S Broadkay, Introduction to Transport Phenomena, McGraw Hill Publications, 1980
2. J R Welty, C E Wicks and R E Wilson, Fundamentals of Momentum, Heat and Mass Transfer, 3rd Ed., 1984
3. Geankoplis, Transport Processes and Separation Processes Principles. 4th Edition, Prentice Hall, 2003

18CH C 22 **PROCESS TECHNOLOGY AND ECONOMICS**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand about the

1. Manufacturing processes of various industry relevant inorganic chemicals
2. Understanding about raw materials, energy sources, consumption and operating conditions of petroleum processing
3. Applying knowledge of unit operations, unit processes to draw flow diagrams for the manufacturing various petrochemical products
4. Application of industry relevant fuels
5. Applying and analyzing profitability of projects

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

1. Explain various sources and processes of manufacture of various industrially important chemicals
2. Apply unit operations to draw block diagrams/ process flow diagrams of the processes used for manufacture of industrially important chemicals
3. Find out energy sources, requirement of raw materials and operating conditions of petrochemicals
4. Outline the application of industry relevant fuels
5. Apply various economic equations to evaluate project viability

UNIT- I

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Inorganic Chemicals, such as: inorganic acids Sulphuric Acid by contact process, Phosphoric Acid by sulphuric Acid digestion process, chloro-alkali chemicals (Soda ash by Solvay process, Caustic Soda) Ammonia, Fertilizers (Urea, MAP and DAP)

UNIT- II

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for Petroleum processing: Constituents of petroleum, various unit operations and unit process of refining products of refining and cracking operations, syngas and hydrogen by steam reforming of hydrocarbons

UNIT- III

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Petrochemicals: Chloromethanes, Ethanol amines, Acrylonitrile, Acetylene, phenol, toluene, xylene.

UNIT- IV

Industrially relevant fuels, coal, coal based chemicals and fuels Common utilities such as electricity, cooling water, steam, hot oil, refrigeration and chilled water

UNIT- V

Introduction to project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost variable cost, fixed cost, breakeven point and their estimation. Estimation of Working Capital. Balance sheets, Project financing, concept of interest, (Present Worth, Future Worth) time value of money, depreciation. Profitability Analysis of Projects, Payout time and Rate of return

Text Books:

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013

Suggested Reading:

1. Chemical Process Technology, Moulijn, M. and van Dippen, Wiley, 2013
2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997
3. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005

18CH C 23 **PROCESS INSTRUMENTATION**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	20 Marks
Credits	2

Course Objectives: This course will help the students to understand the
1. Fundamental elements of industrial instruments and their characteristics
2. Different types of temperature measuring instruments and their industrial applications
3. Different types of pressure measuring instruments
4. Different types of flow meters and level measuring devices
5. Methods applied for composition analysis in process industries

Course Outcomes: At the completion of this course students will be able to
1. Identify instruments required in process industry based on their purpose and function
2. Compare the range of operation and working of different temperature measuring instruments
3. Interpret the different pressure measuring instruments based on their application
4. Select the required flow and level measuring instruments for process industry
5. Apply the different methods of composition analysis for industrial analysis

UNIT- I

Importance of industrial instrumentation: Need, significance, applications and classification. Functional units – elements of instruments and their functions as sensors, transducers, transmitters and receivers. Static and dynamic characteristics of instruments.

UNIT- II

Temperature measurement: Expansion thermometers – types, mercury in glass, bimetallic, pressure spring type, drawbacks for industrial applications. Industrial thermocouples – types and range of operation, lead wires, need of thermowells. Industrial resistance thermometers – types of sensors, Resistive Temperature Detectors [RTD], Thermistors. Infrared thermometry – pyrometers, radiation receiving elements, radiation pyrometer, optical pyrometer.

UNIT- III

Pressure measurement: Manometers types – U-tube, well type, enlarged leg, inclined leg, ring balance type. Elastic transducer elements– bourdon, bellow and diaphragm. Electrical pressure transducers – Linear variable differential transformer (LVDT) and strain gauge. Introduction to standard vacuum gauge – McLeod gauge and Pirani gauge.

UNIT- IV

Flow and Level measurement: Flow meters – head type, area type, mass flow meter, electromagnetic flow meters. Level measurement – hydrostatic head, float type, RF capacitance, Radar type.

UNIT- V

Analytical Techniques: Spectroscopic analysis, absorption type – infrared, UV, X-ray and NMR. Emission and Mass spectroscopy Analysis of moisture in gases (humidity) by psychrometer, hygrometer, dew point methods. Introduction to chromatography – types, uses, Gas Liquid Chromatography, Thin layer Chromatography.

Text Books:

1. D Patranabis, Principles of industrial instrumentation, 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi, 2013
2. Donald P Eckman, Industrial Instrumentation, CBS pub and distr. Pvt. Ltd., New Delhi, 2004

Suggested Reading:

1. N V S Raju, Instrumentation Operation, Measurement, Scope and Application, B S Pub., Hyd., 2016
2. Arun K Ghosh, Introduction to Measurements and Instruments, PHI learning Pvt. Ltd., New Delhi, 2013

18CH E 13 **MINERAL PROCESSING TECHNOLOGY**
(Core Elective V)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand
1. Various unit operations involved in mineral processing technology and the mineral concentration processes
2. Importance and principles of materials handling in the mineral processing plant with special emphasis on feeding and conveying of bulk material
3. Opportunities to acquire practical skills in concentrates handling, grade
4. Heavy media separations and separation vessels
5. Recovery and loss calculation and participatory laboratory experiments

Course Outcomes: At the completion of this course the students able to
1. Explain the principles governing a range of processes applied in the mineral industry
2. Identify 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. Develop conceptual designs for simple extraction processes
5. Summarize the operation of beneficiation units for coal and mineral

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 (warmancyclosizer), 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
Flotation – History and theory: Flotation practice: ore and pulp preparation, contact angle, work of adhesion; Flotation 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 collection (Copper, Iron, Gold).

Text Books:

1. B.A.Wills – "Mineral Processing Technology", 7th edition Maxwell International Edition - 1987
2. Introduction to Mineral Processing (Kelly and Spottiswood)
3. Principles of Mineral Dressing (A. M. Gaudin)
4. Coal Preparation (J. W. Leonard)
5. The Coal Handbook: Towards Cleaner Production (D. Osborne)

Suggested Reading:

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

18CH E 14 **CORROSION ENGINEERING**
(Core Elective V)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the
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 to
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

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 oxidisers, 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 HUhlig, Wiley, 3rd edition,2011
2. Handbook of Corrosion Engineering, Pierre Roberge, McGraw- Hill, New York,2000

18CH E 15 **SCALE-UP METHODS**
(Core Elective V)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course helps the students to

1. Understand prototypes, models, principle of similarity Understand physical, static, dynamic, thermal and chemical similarity understand the scale-up principles of mixing and heat transfer equipment
2. Develop scale-up techniques for chemical reactors
3. Develop scale-up techniques for both batch and continuous separation process

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

1. Explain principles of scale-up
2. Apply dimensional analysis technique for scale up problems
3. Deduce the scale up of mixers and heat exchangers
4. Outline the scale up of chemical reactors
5. Design the distillation columns and packed towers scale up process.

UNIT- I
Principals of Similarity, Pilot Plants & Models: Introduction to scale-up methods, pilot plants, models and principles of similarity, Industrial applications.

UNIT- II
Dimensional Analysis and Scale-Up Criterion: Dimensional analysis, regime concept, similarity criterion and scale up methods used in chemical engineering, experimental techniques for scale-up.

UNIT- III
Scale-Up of Mixing and Heat Transfer Equipment: Typical problems in scale up of mixing equipment and heat transfer equipment.

UNIT- IV
Scale-Up of Chemical Reactors: Kinetics, reactor development & scale-up techniques for chemical reactors

UNIT- V
Scale-Up of Distillation Column and Packed Towers: Scale-up of distillation columns and packed towers for continuous and batch processes.

Text Books:

1. Marko Zlokamik, Scale-up in Chemical Engineering, Wiley-VCH, 2ndEdition, 2006
2. Johnstone, Thring, Pilot Plants Models and Scale-up methods in Chemical Engineering, McGraw Hill, NewYork, 1962

Suggested Reading:

1. Hoyle W, Pilot Plants and Scale-Up, Royal Society of Chemistry, 1999
2. Bruce Nauman E, Chemical Reactor Design, Optimization and Scale-up, McGraw Hill Handbooks, New York, 2002

18ME O 11 **MODERN MANUFACTURING PROCESSES**
(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Understand the opportunities and challenges brought about by Industry4.0.
2. Familiarize with the basic concept and process of digital manufacturing.
3. Understand real-life scenarios and recommend the appropriate use of 3D printing technology.
4. Acquire the knowledge of non-traditional machining processes.
5. Learn the procedure for the fabrication of micro-electronic devices.

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

1. Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.
2. Apply the concept, architecture and process of digital manufacturing.
3. Evaluate real-life scenarios and recommend the appropriate use of 3Dprintingtechnoloy
4. Compare various non-traditional machining processes.
5. Demonstrate the procedure for the fabrication of micro-Electronic devices.

UNIT –I

Introduction to industry 4.0: The various industrial revolutions, digitalization and its impact, comparison of industry 4.0 factory and today's factory. business issues in industry 4.0, internet of things (IoT) & industrial internet of things (IIoT) & internet of services, smart manufacturing, cyber physical systems, trends of industrial big data, cloud computing, robotic automation and collaborative robots, cyber security.

UNIT –II

Digital manufacturing process : Introduction to digital manufacturing and design, concepts , research and development status of digital manufacturing, definition, features and development of digital manufacturing, transition to digital manufacturing and design, advantages of digital manufacturing and design. digital thread, information sharing in the digital thread, data procurement standards, manufacturing supply chains, integrated information systems in the product lifecycle.

UNIT –III

Additive manufacturing processes: Introduction to 3D printing, evolution, distinction between 3D printing & CNC machining.

Processes and principles: Photo polymerization, powder bed fusion, binder jetting, material jetting, sheet metal lamination, material extrusion, direct energy deposition. Application in aerospace industry, automotive industry, jewelry industry, medical and bioengineering applications, planning and simulation of complex surgery, forensic science.

UNIT–IV

Nontraditional machining processes: Requirement, process description of ultrasonic machining, abrasive jet machining, water jet machining, water abrasive jet machining, electro discharge machining, electrochemical machining, chemical machining, ion beam etching, plasma arc machining, laser beam machining and electron beam machining.

UNIT-V

Fabrication of micro- electronic devices: Introduction, semiconductors and silicon, fabrication of integrated circuits and silicon wafers, film deposition, lithography, etching, diffusion and ion implantation, metallization and testing, bonding and packaging, printed circuit boards.

Text Books:

1. Mikell P. Grover, “Fundamentals of Modern Manufacturing Materials, Processes and Systems”, 4/e, John wiley& sons, inc,2009.

2. Zude Zhou, Shane (Shengquan) Xie and DejunChen, “Fundamentals of Digital Manufacturing Science”, Springer-Verlag London Limited,2012.
3. Brent Stucker, David Rosen, and Ian Gibson, “Additive Manufacturing Technologies” Springer,2010.

Suggested Reading:

1. Serope Kalpak Jain, Steven R.Schmid, “Manufacturing Engineering and Technology”, 4/e, Pearson Education India, 2006
2. Amitabh Ghosh and Mallick, “Manufacturing Science”, Assoc. East West Press Pvt. Ltd., 4/e,2011.

18EE O 02 **ENERGY MANAGEMENT SYSTEMS**
(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course objectives:
1. To know the concept of Energy management
2. To understand the formulation of efficiency for various engineering systems
3. To explore the different ways to design various technologies for efficient engineering systems.

Course Outcomes: After completion of this course, students will able to:
1. Know the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Evaluate the performance of existing engineering systems
4. Explore the methods of improving energy efficiency in different engineering systems
5. Design different energy efficient devices.

UNIT-I

Basics of Energy and its Various Forms: Overview of engineering, elements Solar energy,electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, elements of bio energy, bio mass energy conservation, elements of geothermal energy, sources of geothermal energy, sources of chemical energy, fuel cells, Energy Scenario in India

UNIT-II

Energy Management - I: Defining Energy management, need for energy management, energy managementtechniques, importance of energy management, managing the energy consumption, energy crisis, environmental aspects

UNIT-III

Energy Management-II: Energy management approach, understanding energy costs, bench marking, energyperformance, matching energy use to requirement, optimizing the input, energy requirements, energy audit instruments, material and energy balance diagrams, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, restructuring of the energy supply sector, energy strategy for the future

UNIT-IV

Energy Efficient Technologies-I: Importance of energy efficiency for engineers, Energy efficient technology in mechanical engineering: Heating, ventilation and air-conditioning, boiler and steam distribution systems Energy efficient technology in civil engineering: future of roads, harnessing road and transport infrastructure;

UNIT-V

Energy Efficient Technologies-II: Energy efficient technology in electrical engineering: Electricity billing,electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors; Energy efficient technology in chemical engineering: green chemistry, low carbon cements, recycling paper

Text Books:
1. Umesh Rathore, 'energy management', Kataria publications, 2nd ediiton, 2014.
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
3. 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 Queensland University of Technology.

Suggested Reading:
1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

2. K V Shama, P Venkataseshaiah, "Energy management and conservation", I. K. International Publishing agency pvt ltd., 2011, ISBN: 978-93-81141-29-8

18ME O 03 **RESEARCH METHODOLOGIES**
(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course 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.

Course 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 research 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.

18CE O 02 **DISASTER MITIGATION AND MANAGEMENT**
(Open Elective-II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course aims to,
1. Equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities.
2. Impart knowledge in students about the nature, causes, consequences and mitigation measures of the various Hydro-meteorological disasters.
3. Introduce the concepts of causes, consequences and mitigation measures of the various Geographical disasters.
4. Enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters.
5. Equip the students with the knowledge of the impacts of disaster, chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of Central and State Level Authorities

Course Outcomes: Upon completion of this course, the student will be able to,
1. Identify and understand the fundamental terminologies in disaster management.
2. Distinguish between the Hydro-meteorological disasters and apply the concepts of structural and non-structural mitigation measures.
3. Categorize different Geographical Disasters and apply the knowledge in utilizing the early warning systems.
4. Analyze various mechanisms and consequences of human induced disasters.
5. Develop an awareness of disaster management phases and formulating effective disaster management plans, ability to understand various participatory roles of stakeholders- Central and State Government bodies at different levels.

UNIT- I:
Introduction: Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster- Natural and manmade; Introduction to Disaster management cycle; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

UNIT- II:
Natural Disasters:
Hydro meteorological disasters:
Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Applications. Case studies related to various hydro-meteorological disasters.

UNIT- III:
Geographical based disasters: Causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various geographical based disasters.

UNIT- IV:
Human Induced Disasters: Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to various chemical industrial hazards eg: Bhopal gas leakage; Management of chemical terrorism disasters and biological disasters; Case studies related to power break downs, fire accidents, traffic accidents, oil spills and stampedes, building failure disasters.

UNIT- V:
Concept of Disaster Impacts and Management:
Disaster impacts- environmental, physical, social, ecological, economical, political, etc.; health, psycho-social issues; demographic aspects, gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

Disaster management cycle and its phases, risk analysis, vulnerability and capacity assessment; Post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

Text Books:

1. Pradeep Sahni, "Disaster Risk Reduction in South Asia", Prentice Hall, 2003.
2. B. K. Singh, "Handbook of Disaster Management: Techniques & Guidelines", Rajat Publication, 2008.

Suggested Reading:

1. Ministry of Home Affairs, Government of India, "National Disaster Management Plan, Part I and II",
2. K. K. Ghosh, "Disaster Management", APH Publishing Corporation, 2006.
3. http://www.indiaenvironmentportal.org.in/files/file\disaster_management_india1.pdf
4. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs)
5. Hazards, Disasters and your community: A booklet for students and the community, Ministry of Home Affairs.
6. Disaster Medical Systems Guidelines, Emergency Medical Services Authority, State of California, EMSA no.214, June 2003.
7. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings, Geneva: IASC.
8. http://ndma.gov.in/ (Home page of National Disaster Management Authority)

18CS O 10 **MACHINE LEARNING USING PYTHON**
(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The main objectives of this course are:

1. Get an idea of Machine Learning algorithms to solve real world problems.
2. Study various machine learning algorithms.
3. Analyze data using machine learning techniques.

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

1. Define the basic concepts related to Python and Machine Learning.
2. Describe the feature engineering methods, regression techniques and classification methods.
3. Apply Python packages for data visualization. Text and time series data analysis using NLP toolkit.
4. Evaluate and interpret the results of the various machine learning techniques.
5. Solve real world problems using deep learning framework

UNIT - I

Introduction to Machine Learning: Introduction, Machine Learning process. Introduction to Python: Features, sources and installation of Python, IDEs, Basics of Python, Data Structures and loops.

UNIT - II

Feature Engineering: Introduction to Features and need of feature Engineering, Feature extraction and selection, Feature Engineering Methods, Feature Engineering with Python. Data Visualization: Various charts, histograms, plots.

UNIT - III

Regression: Simple and multiple regressions, Model assessment, various types of errors, errors, ridge regression, Lasso regression, non-parameter regression. Classification: Linear classification, logistic regression, Decision Trees, Random Forest, Naïve Bayes.

UNIT - IV

Unsupervised Learning: Clustering, K-Means clustering, Hierarchical clustering. Text Analysis: Basic text analysis with Python, regular expressions, NLP, text classification. Time Series Analysis: Date and time handling, window functions, correlation, time series forecasting.

UNIT - V

Neural Network and Deep Learning: Neural network- gradient descent, activation functions, parameter initialization, optimizer, loss function, deep learning, deep learning architecture, memory, deep learning framework. Recommender System: Recommendation engines, collaborative filtering.

Text Books:

1. Abhishek Vijavargia “Machine Learning using Python”, BPB Publications, 1st Edition, 2018
2. Tom Mitchel “Machine Learning”, Tata McGraWHill, 2017
3. Reema Thareja “Python Programming”, Oxford Press, 2017.

Suggested Reading:

1. Yuxi Liu, “Python Machine Learning by Example”, 2nd Edition, PACT, 2017

Online Resources:

1. https://www.guru99.com/machine-learning-tutorial.html
2. https://www.tutorialspoint.com/machine_learning_with_python/index.htm
3. https://www.tutorialspoint.com/python/
4. https://docs.python.org/3/tutorial/
5. https://www.geeksforgeeks.org/machine-learning/

18CH C 24 PROCESS INSTRUMENTATION AND CONTROL LAB

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	25 Marks
Credits	1.5

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

1. **Evaluate** the performance of a U-tube manometer
2. **Assess** the discharge efficiency of an orifice meter
3. **Analyze** step response of simple feedback control systems
4. **Determine** frequency response of control systems
5. **Analyze** the behavior of a control system using different modes of control when subjected to a permanent disturbance
6. **Apply** closed loop and open loop techniques to tune process controllers

List of Experiments

Part I: Process Instrumentation

1. Introduction to basics of control system components, signals and standards
2. Pressure measuring instruments/sensors
3. Level measurement
4. Flow measuring instruments
5. Temperature measuring devices
6. Humidity, density, viscosity and pH measuring devices
7. Pressure controllers: regulators, safety valves
8. Flow control actuators: different types of valves
9. Electrical and pneumatic signal conditioning and transmission
10. Computer process control, PLC, DCS,SCADA

Part II: Process Control

1. Control Valves
2. Flow-level cascade control Trainer
3. Viscosity Measuring Device
4. Level and Flow Measuring Devices
5. Temperature and Pressure Measuring Device
6. Temperature, level, and pressure control trainers
7. Open loop systems: lagged thermometer
8. Transmitters and transducers

Text Books:

1. Donald R Coughanowr , Steven E LeBlanc ,Process Systems Analysis and Control, 3rd edition, McGraw Hill Education (India) Edition2013
2. D Patranabis, Principles of Industrial Instrumentation, , 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi,2013

18CH C 25 PROCESS MODELING AND SIMULATION LAB

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	25 Marks
Credits	1.5

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

1. **Develop** chemical engineering process models based on fundamental laws of mass and energy transfer
2. Dynamically simulate and **interpret** two heated tanks, using MATLAB
3. Dynamically simulate and **analyze** continuous reactors in Series using MATLAB
4. **Adapt** ASPEN software to perform steady state simulation of valves
5. **Apply** ASPEN software for simulation of batch Distillation
6. **Utilize** ASPEN software to design Plug flow reactor

List of Experiments

Part I

1. Introduction to Software Packages. Understanding the basic concepts and steps involved for developing process flow sheet.

Part II

i. Setting up models for simulation

Part III: Dynamic simulation using MATLAB

1. Two-heated Tanks in series
2. Three CSTRs in series at isothermal, constant holdup condition
3. Batch Reactor
4. Vapor Liquid Equilibrium
5. Ideal Binary distillation
6. Gas-Phase Pressurized CSTR

Part IV: Steady State simulation using ASPEN

1. Simulation of reactor systems
2. Simulation of simple units like valves, pumps, flash columns, Heat exchangers
3. Simulation of Distillation columns
4. Flow-sheeting of chemical process.

Text Books:

1. Manjeet KaurBedi, Prof. Vikram Singh, A Textbook Of Simulation And Modeling, Laxmi Publications, 2011

18CH C 26 **PROJECT: PART I**

Instruction	4 Hours per week
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

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 a departmental Committee.

Guidelines for the award of Marks:
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

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Scheme of Instructions of VII Semester of B.Tech. – Chemical Engineering as per AICTE Model Curriculum 2021-22

DEPARTMENT OF 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 in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
	THEORY								
1		Core Elective VI	3	-	-	3	30	70	3
2		Open Elective III	3	-	-	3	30	70	3
	PRACTICALS								
3	18CH C 27	Technical Seminar	-	-	2	-	50	-	1
4	18CH C 28	Project: Part II	-	-	20	Viva	100	100	10
Total			**6**	**-**	**22**	**-**	**210**	**240**	**17**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

Core Elective VI	
18CH E 16	Chemical Process Safety
18CH E 17	Fertilizer Technology
18CH E 18	Chemical Process Synthesis

Open Elective III	
18PYO 01	Histories of Science and Technology
18EG O 02	Gender Sensitization
18EG O 01	Technical writing skills
18CSO 03	IoT and Applications
18CSO 04	Basics of Data Science using R

18CH E 16 **CHEMICAL PROCESS SAFETY**
(Core Elective VI)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Importance of safety culture in process industry.
2. Disregard for ethical decision making based on numerous case studies.
3. Interaction and implementation of trade-offs concept in chemical plant operation.
4. Examples of problems that can occur with inadequate process design, improper process modification.
5. Different case studies related to industrial processes

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

1. Evaluate effect of chemical hazards and risks of toxicants.
2. Analyze chemical incidents and possible consequences to plant facilities, workers, and the general public.
3. Analyze fire and explosion hazards.
4. Integrate safety concepts into chemical plant design.
5. Apply ethics during process plant operation

UNIT – I

Introduction: Process industrial safety –definition, importance. Safety awareness – Safety aspects of site selection, plant planning and layout, check list, inline arrangement of tower drums, exchangers, pumps and main pipelines.
Case studies of major disasters due to safety violations: Chernobyl disaster, Bhopal disaster, recent oil spills. Chemical hazards and workers safety, industrial process case studies.

UNIT – II

Organized labor interest in safety: Involvement of unions in accident prevention, recommendation of occupational health committees. Work Policy of MCA in accident prevention at process industries. Risk assessment procedures (HAZOP) and typical operational practices. Necessary precautionary measures (OSHA). Hazards: Identification and operability studies. Involvement of chemical criminals in process industries and their prevention. DOW Fire and explosion index, calculation of the DOW Fire and EI. Chemical safety data sheets and guides.

UNIT – III

Safety education and training: Training of personnel, on- the- job and job instructed training, meeting and instructional presentations. Effects of toxic Agents, chemicals and smoke on skin, eyes, respiratory tract, digestive tract. Primary protection equipment (PPE) – types, significance and applications. Measuring safety effectiveness: criteria for effective measurement, disabling (Lost-time) injuries, frequency rate, severity rate. Problem related safe-t-score. Involvement of inspector of factories in accident prevention. The technique of safe process design, separation sections, materials handling, storage sections, flow sheet review.

UNIT – IV

Fires and explosions: Definition of fire, fire triangle, Classification of fires as Class-A, B, C and D. Reaction of fires. Fire extinguishers: Portable fire extinguishers applications and their uses, Construction and working of water, Mechanical foam, CO_2, stored powder, ABC powder. Automatic multiple CO_2 extinguishers in chemical process industries.

UNIT – V

Emergency preparation and accident investigation: On-site and off-site emergency plan and infrastructure, learning from accidents, layered investigation, equipments aiding in diagnosis. Safety audit: Introduction, essentials, requirements, programs and procedures

Text Books

1. D. A. Crowl and J.F. Louvar, “Chemical Process Safety”, Prentice Hall, New Delhi, 2011.
2. Howard H. Fawcett and W. S. Wood, “Safety & Accident prevention in chemical operations”, 2nd Ed., John Wiley and Sons Inc, 1982.

Suggested Reading:

1. Coulson and Richadson, “Chemical Engineering Design”, 3rd ed., Vol 6, TMH, 1999.
2. Fulekar M.H, “Industrial Hygiene and Chemical Safety”, I.K. International Publisher, 2006.
3. Sanders R.E., “Chemical Process Safety: Learning from case Histories”, Butterworth-Heinemann (Elsevier) pub, 2005.

18CH E 17 **FERTILIZER TECHNOLOGY**
(Core Elective VI)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the
1. Use of fertilizers in improving soil productivity and crop yield.
2. Different types of the nitrogenous, phosphatic and potash fertilizers.
3. Various fertilizer application methods.
4. Different organic fertilizer production methods.
5. Environmental impact of fertilizer plants

Course outcomes: At the completion of this course, students will be able to
1. Identify the different nutrients and significance of feed stocks for the production of various nitrogenous fertilizers.
2. Apply different manufacture methods for various phosphorous fertilizers.
3. Explain production methods for potassium and mixed complex fertilizers
4. Explain the need, application techniques and uses of new variety of fertilizers.
5. Summarize effluent treatment methods and impact of fertilizers on environment.

UNIT – I:
Introduction: Fertilizer Technology, Plant Nutrients, Role of essential elements for plant growth. Availability of feed stocks. Nitrogen Fertilizers.
Feed stocks for the production of Ammonia, Ammonia synthesis by Haber and Kellogg processes. By-product ammonia recovery by direct and indirect methods.

UNIT –II
Manufacture of Urea: Manufacture of urea and other nitrogenous fertilizers such as ammonium sulphate, ammonium nitrate, calcium ammonium nitrate, ammonium chloride. Manufacture of nitric acid.

UNIT – III
Phosphorous fertilizers: manufacture of single and triple super phosphate. Production of Mono ammonium phosphate, Di ammonium phosphate and nitro phosphates, Manufacture of phosphoric acid by wet process and thermal process.

UNIT –IV
Introduction to new variety of fertilizers: Potassium fertilizers, mixed and NPK fertilizers. Liquid fertilizers. Bio fertilizers – Introduction, advantages over chemical fertilizers, types and uses.

UNIT –V
Fertilizer application techniques: different soil controlled release fertilizers. Effluent treatment methods for various fertilizer plants. Environmental impact of fertilizer plants on Ecosystem. Indian Fertilizer industry – production Economics and future plans.

Text Books
1. Brahma Mishra, “Fertilizer Technology and Management”, IK International Publishing House Pvt. Ltd., New Delhi, 2012.
2. Dr. ShaliniSuri, “Bio Fertilizers and Bio pesticides”, 1st Ed., APH publishing Corporation, New Delhi, 2011.

Suggested Reading:
1. Fertilizer Association of India, “Fertilizer Handbook”, 2nd Ed., Scientific Publisher, New Delhi, 2009.
2. UNIDO, “Fertilizer Manual”, 3rd edition, Kluwer Academic Publishers, New Delhi,1998.

18CH E 18 **CHEMICAL PROCESS SYNTHESIS**
(Core Elective VI)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course objectives: This course helps the students to
1. Understand chemical process flow sheet and equipment synthesis
2. Understand heuristics for process synthesis
3. Learn optimization of process flow sheet for a given product
4. Learn to design and evaluate project profitability
5. Understand trouble-shooting analysis of equipment

Course Outcomes: At the end of the course, student will be able to
1. Analyze alternative processes and equipment
2. Synthesize a chemical process flow sheet that would approximate the real process
3. Design best process flow sheet for a given product
4. Perform economic analysis related to process design
5. Evaluate project profitability

UNIT – I
Synthesis of steady state flow sheet: Introduction, Flow sheets, General semantic equation of equipment, Generalization of the method of synthesis of process flow sheet, Recycle structure of the flow sheet, separation systems.

UNIT – II
Heuristics for process synthesis: Raw materials and Chemical reactions, Distribution of chemicals, Separations, Heat exchangers and furnaces, pumping pressure reduction and conveying of solids, Reactor design.

UNIT – III
Optimization of flow sheet with respect to heat exchanger: Introduction, Network of heat exchanger, Some necessary conditions for the existence of an optimal heat exchanger network, Maximum heat transfer in a single exchanger, Hot and cold utilities.

UNIT- IV
Safety in Chemical plant design: Introduction, Reliability of equipment, prevention of accidents, Flammability of chemicals, Safety considerations in plant layout, Classification of chemicals and handling problem, Safety consideration in reactor design, Design of safety valves

UNIT- V
Trouble-shooting analysis of equipment and chemical plants, Fault tree analysis of accidents. Reliability consideration in maintenance policies of a chemical plant. Economic evaluation: Methods for Profitability evaluation, Discounted cash flow analysis.

Text Books:
1. Seider W. D., Seader J.D. and Lewin D. R., Product and Process Design Principles: Synthesis, Wiley, 2005.
2. Robin Smith, Chemical Process Design and Integration, John Wiley & Sons Ltd., 2005.

Suggested Reading:
1. Bieglar L.T, Grossman E.I and Westerberg A.W., Systematic Methods of Chemical Process Design, Prentice Hall Inc.,1997
2. Douglas J. M., Conceptual Design of Chemical Processes, McGraw Hill International, 1988.

18 PY O 01 **HISTORIES OF SCIENCE AND TECHNOLOGY**
(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 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 Reading:

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

18EG O 02 **GENDER SENSITIZATION**
(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

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. 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:
3. 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.

18EG O 01TECHNICAL WRITING SKILLS

(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The course will introduce the students to:

1. Process of communication and channels of communication in general and technical writing.
2. Technical Writing and also contextual use of technology specific words.
3. Business letters and technical articles.
4. Technical reports and technical proposals.
5. Transferring data from verbal to graphic and vice versa and making technical presentations.

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

1. Understand the channels of communication and define nature and aspects of Technical communication
2. Compare and contrast technical communication to that of general communication while constructing error free sentences applying features of technical writing.
3. Analyze data, draw inferences to write Journal articles and conference papers and to compose business letters.
4. Evaluate data to draft technical reports and technical proposals.
5. Design a technical presentation by understanding the nuances of presentation skills and also transfer data from verbal to graphic and vice versa

Unit I

Communication – Nature and process.

Channels of Communication – Downward, upward and horizontal and lateral communication. Barriers to communication.

Technical Communication – Definition; oral and written communication. Importance and need for Technical communication. Nature of Technical Communication. Aspects and forms of Technical communication. Technical communication Skills – Listening, Speaking, Reading & Writing.

Unit II

Technical Writing – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

Unit III

Business correspondence – Sales letters, letters of Quotation, Claim and Adjustment letters.

Technical Articles: Nature significance and types of technical articles. Writing an abstract. Journal articles and Conference papers. Elements of technical articles.

Unit IV

Technical Reports: Types, significance, structure, style and writing of reports. Routine reports, Project reports.

Technical Proposals: Definition, types, characteristics, structure and significance.

Unit V

Information Transfer – Graphic to verbal (written) and verbal to graphic.

Technical Presentations: Important aspects of oral and visual presentations.

Text Books :

1. Meenakshi Raman & Sangeeta Sharma, **"Technical Communications-Principles and Practice",** Oxford University Press, Second Edition, 2012.
2. 1.M Ashraf Rizvi, **"Effective Technical Communication",** Tata McGraw Hill Education Pvt Ltd, 2012.

Suggested Reading:

1. Kavita Tyagi & Padma Misra, **"Basic Technical Communication",** PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, **"Business Correspondence and Report Writing",** Tata McGraw Hill, 2003

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18_mg13/preview
2. https://www.technical-writing-training-and-certification.com/
3. https://academy.whatfix.com/technical-writing-skills

18CSO 03 **IoT AND APPLICATIONS**
(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Pre-requisites: Programming Basics.

Course Objectives: The main objectives of this course are:
1. Impart necessary and practical knowledge of components in Internet of Things.
2. Understand working of IoT Systems.
3. Develop skills required to build IoT based systems in the field of biotechnology.

Course Outcomes: On Successful completion of this course, student will be able to
1. Understand Internet of Things and its hardware and software components.
2. Interface I/O devices, sensors & communication module.
3. Remotely monitor data and control devices.
4. Hypothesizing real time IoT based projects.
5. Advance towards research based IoT in the field of biotechnology

UNIT – I
Introduction to IoT: Sensors, Types of sensors and Transducers, Actuators and Types of Actuators.

UNIT – II
Basics of Networking: Functional Components of IoT , IoT interdependencies, IoT Service oriented architecture, IoT categories, IoT gateways, IoT and associated technologies, Key technologies for IoT, IoT challenges.

UNIT – III
IoT Hardware Components: Computing (Arduino/ Raspberry Pi), Communication, Sensors, Actuators, I/0interfaces, Programming API's (for Arduino/Raspberry Pi).

UNIT – IV
IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, Authorization of devices

UNIT – V
IoT Systems and Applications: Smart Lighting, Weather Monitoring System, Weather Reporting Bot, Forest Fire Detection, Alcohol Detection System, Smart Parking Environment.**,** Drip-irrigation, Biological water treatment system**,** Work flow Automation in Industries, Smart Intrusion Detection System, monitoring space risks and hazardous conditions in industrial regions like underground tanks , trap door margins.

Text Books:

1. Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases",CRCPress,2017.
2. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi, 2018.
3. ArshdeepBahgaand Vijay Madisetti, "Internet of Things: A Hands- on Approach",Universities Press,2014.

Suggested Reading:

1. Dr. SRN Reddy, RachitTirnkraland Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETILabs,2018.
2. Adrian Mc Ewen, "Designing the Internet of Things", Wiley, 2013.
3. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017.
4. CunoPfister,"GettingStartedwiththeInternetofThings",0Reilly Media,2011.
5. O.Vermesan, P. Fries**s, "**Internet of Things– Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, SeriesinCommunications,2013.

Online Resources / Weblinks / NPTEL Courses:

1. LiDaXu, WuHe, and ShancangLi, “Internet of Things in Industries: A Survey “, IEEE Transactions on Industrial Informatics, Vol.10,No. 4, Nov.2014.
2. Gotovtsev, Pavel M., and Andrey V. Dyakov. “Biotechnology and Internet of Things for green smart city application.” 2016 IEEE 3rd World Forum on Internet of Things (WF-IoT). IEEE, 2016.
3. Yanjing, Sun,etal. “Research and design of agriculture informatization system based on IOT.” Journal of Computer Research and Development 48(2011):316-331.
4. Somov, Andrey, etal.“Bacteria to power the smart sensor applications: Yanjing, Sun, etal. “Research and design of agriculture informatization system based on IOT.” Journal of Computer Research and Development 48(2011):316-331.
5. Han, Shuqing, etal. “Analysis of the frontier technology of agricultural IoT and its predication research. ”IOP Conference Series: Materials Science and Engineering.Vol.231.No.1.IOP Publishing, 2017.

18CSO 04 **BASICS OF DATA SCIENCE USING R**
(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Pre-requisites: Probability and Statistics, basics of programming languages.

Course Objectives: The main objectives of this course are:
1. Understand R programming language.
2. Explore the programming skills needed to use R tool for statistical analysis of Biological data.
3. Analyze biological data.

Course Outcomes: On Successful completion of this course, student will be able to
1. Summarize the basics of R and in-built data visualization packages.
2. Describe the data analysis using Bayesian and stochastic modeling.
3. Relate Gibbs, Z- sampling distributions and compare the binomial, chi-square, wilcoxon and Fisher's exact tests in hypothesis testing.
4. Explore the ANOVA in Regression analysis and classify the multivariate data.
5. Experiment with the biological data using R tool and apply clustering algorithms to biological data.
6. Identify R commands for data manipulation and database technologies for datasets of bioinformatics

UNIT - I
Basics of R: Introduction, R features, setting up and exploring R environment, loading packages, types of data objects in R, working with R data objects, Controlling work space, importing files. Programming with R: Variables and assignment, operators, control structures, Functions-built-in, writing own functions, package creation.

UNIT - II
Data Analysis and Graphics: Data summary functions in R, Graphics technology in R, saving graphics, additional graphics packages. Bayesian Data Analysis: Need of Bayesian approach, Application of Bayes rule, Priors, Likelyhood functions, evaluating the posterior, Applications of Bayesial Statistics in Bioinformatics. Stochastic Modeling: Stochastic process and Markov Processes, Classification of Stochastic processes, modeling a DNA sequence with Markov Chain, Characteristics of Markov Chain.

UNIT - III
MCMC using Brugs: ABO blood type example. Gibbs sampling. Statistical Inference: Sampling distributions, Parameter estimation, interval estimation, bootstrapping, R packages for bootstrapping. Hypothesis Testing: Package ctest, Binomial test, comparing variances, Wilcoxon tests, Chi-Square test, Fisher's Exact tests, Likelihood Ratio tests.

UNIT - IV
ANOVA and Regression: ANOVA table, perforating ANOVA using R, graphical analysis of ANOVA comparison, Regression: Correlations, linear regression model, fitting and testing of regression model, generalization of the model. Working with Multivariate Data: Multivariate data, sample statistics, display of multivariate data, outliers and principal components. Classification of discriminate analysis- classification with two population and more than two populations, cross validation classification trees.

UNIT - V
Clustering methods: measures of dissimilarities, K-means clustering, K-Medoid clustering, Hierarchical clustering-Agglomerate and divisive. R Packages: Bio-conductor and Seqin R.
Data Technologies: R for Data manipulation, example, Database technologies, Bioinformatics resources on the WWW.

Text Books:

1. Kim Seefeld, Ernest Linder, "Statistics using R with Biological examples", 2007 (https://cran.r-project.org/doc/contrib/Seefeld_StatsRBio.pdf).
2. Robert Gentleman, "R Programming for Bioinformatics", 1st Edition, CRC Press, 2008.

Suggested Reading:

1. ArvilCohhlan "A Little Book of R for Bioinformatics", Release 1.0, CC ver 3.0

Online Resources:

1. https://epdf.tips/r-programming-for-bioinformatics.html
2. https://epdf.tips/r-programming-for-bioinformatics.htmlhttps://www.cyclismo.org/tutorial/R/object Oriented.html
3. https://www.w3schools.in/r/object-oriented/

18CH C 27 **TECHNICAL SEMINAR**

Instruction	2 Hours per week
CIE	50 Marks
Credits	1

Course Outcomes: At the end of the course, the student 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

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.

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		
Sl No.	Description	Max Marks
1.	Contents and relevance	10
2.	Presentation skills	10
3.	Preparation of PPT slides	05
4.	Questions and answers	05
5.	Report in a prescribed format	20

18CH C 28 **PROJECT: PART II**

Instruction	20 Hours per week
CIE	100 Marks
SEE	100 Marks
Credits	10

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

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	Max .Marks	Evaluation Criteria / Parameter
Department Review Committee	10	Review 1
	15	Review 2
	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 awarding marks in SEE: (Max. Marks: 100)

Evaluation	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

OPEN ELECTVES OFFERED BY CHEMICAL ENGINEERING DEPARTMENT

18CH O 01 **NUCLEAR ENGINEERING**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Fundamentals of nuclear decay reactions, fission and products.
2. Types of nuclear fuel materials, properties, characteristics and enrichment methods.
3. Non-fuel materials required for construction of the reactor structurals, incore components.
4. Different types of reactors, concepts of heat removal, control and safety systems.
5. Spent fuel management.

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

1. Identify the radioactive elements as nuclear fuel.
2. Illustrate techniques for enrichment of fuel materials.
3. Outline properties and irradiation effects on materials for design of cladding and other incore structures.
4. Understand concepts of heat removal, control and safety needs for operation of nuclear reactors .
5. Summarize safe handling, storage and reprocessing of spent fuel.

UNIT – I Nuclear fission:

Nuclear energy, radioactivity, atomic structure and isotopes of radioactive material, mass defect and binding energy, nuclear stability, half-life, radioactive decay–alpha decay, beta decay, gamma rays. Segre-chart and fission products, Neutron reactions, prompt and delayed neutrons, fission cross-sections, fission rate and reactor power.

UNIT – II Nuclear fuel materials:

Types of fuel materials, characteristics, properties of different reactor fuels. Nuclear fuel cycle – flowsheet, process description, wet process and dry process. Pre-reactor fuel operations – isotopic enrichment requirement. Gas-diffusion process and gas-centrifuge process – principle, working mechanism, process model, advantages and limitations. Breeding ratio and fuel utilization.

Nuclear reactor materials: Characteristics, classification, mechanical properties, thermal properties, nuclear radiation effects, different types of corrosion, structural and cladding materials, moderator and reflector materials.

UNIT – III Reactor safety and Radiation safety:

Biological effects of radiation, Safety requirements of a nuclear power plant, major nuclear accidents

UNIT – IV Nuclear fission reactors:

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).

UNIT – V Spent fuel management:

Characteristics of spent fuel, storage, handling and disposal methods. Reprocessing of spent fuel – flowsheet, solvent extraction 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.

18CH O 02 **PAINT TECHNOLOGY**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. To give fundamental concepts in paints (including industrial paints and domestic paints)
2. Basic properties, uses of main ingredients like pigments, extenders, binders, solvents.
3. To know more about paint application systems (both air drying paints and stoving paints of liquid paints and power paints).
4. Study of paint formulation including manufacturing of different types of paints and special paints.
5. Study about quality of paints (including paint tests and paint defects).

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

1. Identify the suitable paints for domestic and industry purpose
2. Study more about specific paint manufactures.
3. Outline main ingredients of paints, their manufacture and properties.
4. Explain the usage of different types of solvents for both industrial paints and domestic paints and also about paint solid structures (Resins).
5. Identify the suitable application methods for powder and liquid paints.

UNIT-I

Significance of Surface coatings- Scope, properties, applications & uses. Major components of surface coatings. Fundamentals of film formation Classification of Paints: Air drying paints, stoving paints, their properties and uses. Liquid paints & powder paints, their properties & uses.

Manufacture of Paints: Distempers- Manufacture, properties & uses. Powder Paints- Manufacture, properties & uses. Enamel - Manufacture, properties & uses.

UNIT – II

Participation of Pigments: Importance of pigments - their basic properties, uses & their applications.

Classification of pigments: Inorganic & organic pigments. Special properties of pigments: Criteria for selection of color, tinting strength, fastness to light, bleeding, hiding power, refractive index, particle size & anticorrosive properties. Manufacture of Pigments: Titanium di-oxide, red lead, Ultramarine blue.

UNIT – III

Manufacture of Extenders: Importance, properties & significance. Blanc fixe, China clay, Gypsum, Mica & talc.
Solvents: Importance, uses & their properties, Manufacture of solvents: Turpentine, Alcohols- Methyl Alcohol,

Ethyl Alcohol, n-Propyl Alcohol. Natural Resins: Rosin & shellac. Synthetic Resins: Alkyd resins, phenolic resins, amino resins.

UNIT – IV

Types and Application methods of paints: Air drying paints, industrial liquid stoving paints & industrial stoving powder paints. Brush application, Roller coating, spray application, electrostatic spray application. Testing of Paints: Wet paint & dry paint testing film like thickness, adhesion, resistance ,gloss, impact & paint coverage. Defects in paints & paintings & their remedies: defects in grinding skinning, sagging, bleeding, flooring, floating, brushing, orange peel, fish eye, brush marks, lifting.

UNIT – V

Durable coatings with special properties: Importance, Significance & their applications. Powder Coatings, Water soluble coatings, aluminum coatings, water proof coatings, heat resistant coatings, automobile coatings,
fire retardant coatings, space, air craft coatings, swimming pool coatings and Anti Micro growth Paints (Marine Paints).

Text Books:

1. W.M. Morgans, "Outline of Paint Technology", Edward Arnold Publishers, London, 1990
2. R. Lambourne & T A Strivens, "Paint & Surface coatings", Second edition, 1999

Suggested Reading:

1. Patton Temple, "C Pigment Flow & Pigment Dispersion", Wiley Inter science, 1979
2. Swaraj Paul, " Surface Coatings science and technology" , 1995

18CH O 03 **PHARMACEUTICAL TECHNOLOGY**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Grade of chemicals, Principles & Various Tests.
2. Preparation & testing of Pharmaceuticals & final chemicals.
3. Concepts & Principles to draw the flow sheets.
4. Methods & equipment used for Tablets, Capsules Preparation
5. Sterilization methods.

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

1. Outline the grades of chemicals, identify the Impurities & limit tests.
2. Summarize the preparation, tests, properties of Pharmaceuticals & fine Chemicals.
3. Develop flow sheets for Manufacturing Pharmaceuticals.
4. Develop flow sheets for Manufacturing Chemicals.
5. Demonstrate theoretical knowledge about tablet & Capsule making.
6. Know various sterilization methods.

UNIT I

Introduction:Practice of the following unit operation in pharmaceutical industries: Heat transfer, evaporation, distillation, dry, mixing size reduction, crystallization, filtration, size separation, conveying, humidification, air conditioning and refrigeration, Formulation, development of sterile dosage forms. A brief outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulfate in Pharmaceuticals.

UNIT II

Outlines of Preparation, properties, uses and testing of the following Pharmaceuticals- sulfacetamide, paracetamol, riboflavin, nicotinamide, Outlines of Preparation, properties, uses and testing of the following fine chemicals - Methyl orange, fluorescence, procaine hydrochloride, para amino salicylic acid, isonicatinic acid hydrazide

UNIT III

Study of Manufacture & Production of Pharmaceuticals – aspirin, penicillin, calcium gluconate with uses Properties flow sheets and testing Methods. Production facilities, environmental control and personnel in the production of sterile dosage form, compounding, processing, filtration, sealing, sterilization, packing and labeling of sterile dosage forms. Quality control tests like sterility, pyrogen, clarify, safety and leakage testing, types of tablets. Manufacture of vitamins B, D, E; important vaccines, cancer and neurological medicines

UNIT IV

Study of Manufacture & Production of Chemicals with flowsheets, properties uses and testing of the following: ferric ammonium citrate, pthallic anhydride and phenol flourobenzene process and benzene sulfate process, other processes in outline only.

UNIT V

Manufacturing of tablets by wet granulation, dry granulation and direct compression. Tablet processing problems and defects, tablet standardization: hardness, friability, weights variation, disintegration, dissolution and content uniformity tests, Capsules: Hard gelatin capsule, capsule size, formulation and preparation of filled hard gelatin capsules, soft gelatin capsule, soft gel – manufacturing procedures. Sterilization: introduction, risk factor, methods of sterilization, heat (dry and moist), heating with bactericide, filtration, gaseous sterilization and radiation sterilization, suitable example to be discussed
Pharmaceutical packing: Packing components, types of packing containers and closures, materials used for and their pharmaceutical specification, method of evaluation, stability aspects of packaging materials.

Text Books

1. Remington's Pharmaceutical Science,18th ed, John Wiley & Sons, 1990.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley &Sons,. 1965.

Suggested Reading:

1 E.A. Rawlins, Bentely's Textbook of Pharmaceutics, 8 th Edition, BaillereTindill, London, Oxford University Press, 2002.
2 Textbook of Pharmaceutical Packaging Technology 1st ed, Kaushik A, CBS 2011