Semester: VII		
SOLID WASTE MANAGEMENT (Theory)		
Course Code: MVJ21CH721		CIE Marks:50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Impart the knowledge of present methods of solid waste management system and to analyze the drawbacks.	
2	Understand various waste management statutory rules for the present system.	
3	Analyze different elements of solid waste management and design and develop recycling options for biodegradable waste by composting.	
4	Identify hazardous waste, e-waste, plastic waste and bio medical waste and their management systems.	
5	Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system.	

UNIT-I	
Definition, characteristics and perspectives of solid waste, types of solid waste, physical and chemical characteristics, variation of composition and characteristics, municipal, industrial, special and hazardous wastes. **General Aspects:** Overview of material flow in society, Reduction in raw material usage, Reduction in solid waste generation, Reuse and material recovery, General effects on health and environment, Legislations.	8 Hrs
UNIT-II	
Engineered systems: Typical generation rates, Estimation and factors affecting generation rates, on site handling, Storage and processing, Collection systems and devices, Transfer and transport.	8 Hrs
UNIT-III	
Processing techniques: Mechanical volume reduction, Thermal volume reduction, Component separation, Land filling and land forming, Deep well injection.	8 Hrs
UNIT-IV	
Material recovery: mechanical size alteration, electromagnetic separation, drying and dewatering, other material recovery systems, recovery of biological conversion products, recovery of thermal conversion products. **Energy recovery:** energy recovery systems and efficiency factors, determination of output and efficiency, details of energy recovery systems, combustion incineration and heat recovery, gasification and pyrolysis, refuse derived fuels (RDF).	8 Hrs
UNIT-V	
Hazardous wastes: classification, origin and reduction at source, collection and handling, management issues and planning methods, environmental acts. **Case studies:** major industries and management	8 Hrs

methods used in typical industries – coal fired power stations, textile industry, oil refinery, distillery, sugar industry, radioactive and e-waste generation units.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the physical and chemical characteristics of solid waste and interpret the various techniques involved in reduction of solid waste.
CO2	Explain the various handling, storage, processing, collection, transfer & transport techniques involved in solid waste management.
CO3	Explain the various handling and processing techniques involved in solid waste management.
CO4	Demonstrate the different techniques involved in material and energy recovery from solid waste.
CO5	Explain various techniques to handle hazardous waste and outline the case study on solid waste management with respect to various chemical industries.

Reference Books	
1.	Solid Waste Management. Environmental Engineering: Environmental Health and Safety for Municipal Infrastructure, Land Use and Planning, And Industry, Tchobanoglous, G., Sixth Edition, 2009, Wiley, New Jersey. ISBN:9780470083055.
2.	Industrial Solid Waste Management and Land Filling Practice", Dutta, M., Parida, B., Guha, B., & Shreekrishnan, T. K. international edition, 1999, Narosa Publishing House.
3.	Electronic Waste Management, R.E. Hester, Roy M Harrison, Cambridge, UK, 2009, RSC Publication, ISBN: 9780854041121.
4.	Integrated Solid Waste Management, George.C. Tchobanoglous, International edition ,1993, McGraw hill publication. ISBN: 978-0070632370.

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):
Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1	--	--	--	--	--	--	--	--	--	2	--
CO2	2	--	--	--	--	3	3	2	--	--	2	--
CO3	2	--	--	--	--	3	3	2	--	--	2	--
CO4	3	2	--	--	--	3	3	2	--	--	2	--
CO5	3	2	--	--	--	3	3	2	--	--	2	--

High-3, Medium-2, Low-1

Semester: VII		
PHARMACEUTICAL TECHNOLOGY (Theory)		
Course Code: MVJ21CH722		CIE Marks:50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs

Course Learning Objectives: The students will be able to	
1	Learn formulations, tablet and capsule making.
2	Know about biodegradation, natural and synthetic biopolymers.
3	Learn about drug development, testing of materials/cosmetics.
4	Learn pharmaceuticals manufacturing technology.
5	Understanding the packaging of pharmaceuticals products

UNIT-I	
Overview of pharmaceutical industry, classification of pharmaceutical dosage. Introduction to biopharmaceutics, solubilization techniques, suspensions, emulsions etc. Biochemical analysis of pharmaceutical. Introduction to reaction, electrophilic substitution reaction, electrophilic substitution reaction mechanism & application, nucleophilic addition reaction.	8 Hrs
UNIT-II	
Preformulation: Physical form (crystal & amorphous), polymorphism, particle size, shape, solubility profile (pKa, pH), partition coefficient, flow properties, hydrolysis, oxidation, reduction, racemisation, dissolution, permeability, BCS classification and polymerization, mechanism, important chemicals, oxidation-reduction reactions. Rheology of fluids in mixing and blending.	8 Hrs
UNIT-III	
Tablets: Introduction, classification of tablets, formulation/preparing of tablets, granulation methods, tablet coating, types, coating materials, formulation of coating composition, methods of coating, equipment's employed and defects in coating, QC of tablets, apparatus, methods, graphical presentations and analytical tests.	8 Hrs
UNIT-IV	
Capsules: Introduction, advantages, disadvantages, capsule production. Hard and soft gelatine capsules. Evaluation of commercial capsules. **Pellets:** Introduction, formulation, pelletization process, equipment needed. **Pharmaceutical aerosols:** Definitions, advantages, limitation, uses, components of aerosols. **Cosmetics:** Introduction, types of cosmetic preparations, formulation of toothpastes, lipsticks, shampoos, hair dyes, cold cream and vanishing cream, sunscreens. **Preparation:** Test for purity of capsules/pellets/cosmetics.	8 Hrs
UNIT-V	
Packaging of pharmaceuticals/ capsules/pellets/cosmetics products,	8 Hrs

factors influencing choice of containers. Legal and official requirements, stability aspects. Quality control tests of packaging materials. **Preparation**: Analyzing thePackaging of any pharmaceuticals/ capsules/pellets/cosmetics.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend the overall life cycle of pharmaceuticals.
CO2	Summarize the integral parts of pharmaceuticals.
CO3	Illustrate the rheology of pharmaceuticals.
CO4	Explains preparation and testing for compounds in medical application
CO5	Outline preparation, purity test and uses of pharmaceuticals.

Reference Books	
1.	Pharmaceutical product development, Jain, N. K. first edition, 2006, CBS publishers & distributors. ISBN:9788123913216, 8123913214.
2.	Essentials of pharmaceutical technology, Semalty, A., Semalty, M., & Rawat, M. S. M. second edition, 2011, PharmaMed Press / BSP Books.ISBN:9789386819994.
3.	The Theory and Practice of Industrial Pharmacy, Lachman, L., & Lieberman, H. A. fourth edition, 2012, CBS Publishers and Distributors Pvt. Ltd.
4.	Organic chemistry, by Clayden J., Greeves N., Warren S., second edition, 2012, Oxford University Press, ISBN 9780199270293

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	--	--	--	--	--	--	--	--	--	3	--
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CO3	2	2	--	--	--	--	--	--	--	--	3	--
CO4	2	2	--	--	--	--	--	--	--	--	3	--
CO5	2	2	--	--	--	--	--	--	--	--	3	--

High-3, Medium-2, Low-1

Semester: VII		
BIOCHEMICAL ENGINEERING (Theory)		
Course Code: MVJ21CH723		CIE Marks:50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Understand and apply the areas of biochemical processes to provide the fundamental background of biological systems.	
2	Explain the concept of biomolecules and micro-organisms.	
3	Develop the equations for kinetics of enzymes in different action.	
4	Enhance knowledge and skills of fermentation processes, Bioreactors and kinetics.	
5	Understanding the importance of downstream processing.	

UNIT-I	
Introduction: Industrial biochemical processes with typical examples, comparing chemical and biochemical processes. Role of a chemical engineer in bioprocess industry. Microbiology: structure of cells: prokaryotes and eukaryotes. Classification of micro-organisms. Taxonomy, control of microorganisms – physical and chemical methods.	8 Hrs
UNIT-II	
Biochemistry: Chemicals of life: lipids, sugars, polysaccharides, amino acids. Vitamins, biopolymers, nucleic acids: RNA, DNA and their derivatives (structure, biological function and importance for life only to be studied). Enzymes and Proteins: Detailed structure of proteins and enzymes. Functions. Methods of production and purification of enzymes. Nomenclature and classification of enzymes. Kinetics and mechanism of enzyme action: Michaelis–Menten, Briggs-Haldane approach. Derivation.	8 Hrs
UNIT-III	
Kinetics of Enzyme Action: kinetics of enzyme catalysed reaction. Reversible enzyme. Two-substrate. Experimental determination of rate parameters: batch and continuous flow experiments. Lineweaver–Burk plot, Eadie-Hofstee and Hanes-Woolf plots, batch kinetics (integral and differential methods). Enzyme Inhibition: effect of inhibitors (competitive, non-competitive, uncompetitive, substrate and product inhibitions), temperature and pH on the rates enzyme catalysed reactions. Determination of kinetic parameters for various types of inhibitions. Enzyme immobilization. Immobilized enzyme kinetics: effect of external mass transfer resistance.	8 Hrs
UNIT-IV	

Fermentation Technology: Ideal reactors: a review of batch and continuous flow reactors for bio kinetic measurements. Microbiological reactors: operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: sources of nutrients. Introduction to sterilization of bioprocess equipment. Growth Kinetics of Microorganisms: Transient growth kinetics (different phases of batch cultivation). Quantification of growth kinetics: substrate limited growth, models with growth inhibitors, logistic equation, filamentous cell growth model. Continuous culture: optimum dilution rate and washout condition in ideal chemostat. Design and analysis of biological reactors	8 Hrs
UNIT-V	
Downstream Processing: Strategies and steps involved in product purification. Methods of cell disruption, filtration, centrifugation, sedimentation, chromatography, freeze drying / lyophilization. Membrane separation Technology: Reverse osmosis, ultrafiltration, micro filtration, dialysis, final steps in purification, crystallization and drying.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain structure of cells, nucleic acids, nomenclature, classification and production of enzymes; derive the rate equation by M-M and Brigs-Haldane approach
CO2	Derive rate equation for given enzyme mechanisms and estimate the kinetic rate parameters
CO3	Describe the effects of Ph, temperature and inhibitors on enzyme catalysed reactions and explain the methods of enzyme immobilization
CO4	Describe the growth cycle phases for batch cultivation and fed-batch reactors and, derive an expression to determine optimum dilution rate.
CO5	Explain medium formulation, operation & maintenance of fermentation process and strategies and steps involved in product purification.

Reference Books	
1.	Biochemical engineering fundamentals, Bailey, J. E., &Ollis, D. F. reprint, 2018, McGraw-Hill.
2.	Principles of fermentation technology, Stanbury, P. F., Whitaker, A., & Hall, S. J., second edition,2013. Elsevier science, UK. ISBN:0080361323.
3.	Shuler, M. L., Kargi, F., &DeLisa, M. Bioprocess Engineering: Basic Concepts, second edition, 2001. New York City, NY: Pearson.
4.	Biochemical Engineering: An Introductory Textbook, Das, D., & Das, D. first edition, 2019, CRC Press. ISBN:9780429031243.

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):
Total marks: 50+50=100
SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of Cos and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

Semester: VII		
INDUSTRIAL POLLUTION & CONTROL (Theory)		
Course Code: MVJ21CH724		CIE Marks:50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs

Course Learning Objectives: The students will be able to	
1	To enhance knowledge and skills in the areas of importance of pollution, analysis & treatment of wastewater, polluted air, solid waste, noise and its control.
2	To inculcate awareness on environmental, societal, ethical, health and safety issues and their relevance in engineering.
3	To understand different types of pollutions.
4	To encourage for optimal resource utilization and sustainable lifestyles.
5	To promote environmental design.

UNIT-I	
Introduction: Importance of environment for mankind. Types of pollution. Damages from environmental pollution. Need of environmental legislations and environmental Acts in India. Environmental Impact Assessment and Challenges. Functions of central and state pollution control boards. Sampling and Analysis of Wastewater: Evaluation, classification and characterization of wastewater. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects.	8 Hrs
UNIT-II	
Wastewater Treatment: Preliminary, primary, secondary, and tertiary treatments of wastewater. Advanced wastewater treatment. Recovery of materials from process effluents. Applications to Industries: Norms and standards of treated water. Origin, characteristics, and treatment methods in typical industries – petroleum refinery, pulp and paper, distillery, and textile processing.	8 Hrs
UNIT-III	
Air Pollution: Nature of air pollution. Classification of air pollutants. Sources of air pollutants. Air quality criteria and standards. Plume behavior and dispersion of air pollutants. Sampling of pollutants. Methods of estimation of air pollutants.	8 Hrs
UNIT-IV	
Air Pollution Control: Control methods for particulates and gaseous pollutants. Air pollution control methods and equipment. Source collection methods: raw material changes, process changes, and equipment modification. Air pollution Control equipment. Origin, control methods, and equipment used in typical industries-	8 Hrs

metallurgical industries, and cement industries.	
UNIT-V	
Solid Waste Management: Origin, classification and microbiology. Engineered systems for solid waste management – generation, onsite handling, storage, collection, transfer and transport, composting, sanitary land filling. Noise Pollution: Generation of noise, control strategies in industries. Recent trends in industrial waste management, cradle to grave concept, lifecycle analysis, clean technologies.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Discuss the fundamentals of environmental pollution and the associated legal aspects.
CO2	Explain various wastewater treatment methods and the origin, characteristics, and treatment methods in typical industries.
CO3	Interpret the aspects of air pollution and the methods of estimating various air pollutants.
CO4	Outline the control strategies for industrial air pollution control to be within the ambit of environmental regulations.
CO5	Explain different techniques for municipal solid waste management, noise pollution and the recent trends in industrial waste management.

Reference Books	
1.	Environmental Pollution Control Engineering, C.S. Rao, second Edition (Reprint), 2015, New Age International, ISBN: 978-81-224-1835-4.
2.	Waste Water Engineering Treatment Disposal Reuse, Metcalf and Eddy, fourth Edition, 2003, Tata McGraw Hill, ISBN: 978-0071241403.
3.	Pollution Control in Process Industries, S.P. Mahajan, 27th Edition, 2012, Tata McGraw Hill, ISBN: 9780074517727.
4.	Principles and practices of air pollution control and analysis, Mudakavi, J. R. first Edition, 2010. IK International Pvt Ltd. ISBN: 9789380026381

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	--	--	--	3	3	3	2	--	--	--
CO2	3	3	--	--	1	3	3	3	2	--	--	--
CO3	3	3	--	--	--	3	3	3	2	--	--	--
CO4	3	3	--	--	1	3	3	3	2	--	--	--
CO5	3	3	--	--	1	3	3	3	2	--	--	--

High-3, Medium-2, Low-1

Semester: VII		
CHEMICAL PROCESS INTEGRATION (Theory)		
Course Code: MVJ21CH731		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Understand process synthesis and analysis based on Pinch concept.
2	Apply mass & heat exchange networking, to retrofit process and setting up targets for energy and mass minimization.

UNIT-I	
Graphical techniques: Overall mass targeting, direct recycle strategies.	8 Hrs
UNIT-II	
Synthesis of Mass Exchange Network: Graphical approach, algebraic approach to targeting direct recycles.	8 Hrs
UNIT-III	
Algebraic Approach: To targeting mass exchange network, visualization strategies: for development of mass integrated system	8 Hrs
UNIT-IV	
Heat Integration: Heat exchanger networks, graphical and algebraic methods for heat integration, combined heat and power integration excluding co-generating targeting	8 Hrs
UNIT-V	
Optimization: Graphical method, simplex method, single variable optimization, multivariable optimization	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Solve process integration and direct recycle problems using analytical and graphical techniques
CO2	Solve direct recycle problems using algebraic techniques and to synthesize MEN with pinch analysis
CO3	Synthesize MEN using algebraic techniques and to solve problems using property integration
CO4	Apply the concept of pinch analysis to synthesize HENs to find the minimum heating and cooling utilities by graphical & algebraic tools also to synthesize combined heat & power pinch diagrams to solve problems
CO5	Synthesize MEN and HEN problems using mathematical optimization tools

Reference Books	
1.	Process integration. El-Halwagi, M. M. (2006). Elsevier.
2.	Chemical process: design and integration. Smith, R. (2005). John Wiley & Sons.
3.	Pinch analysis and process integration: a user guide on process integration for the efficient use of energy. Kemp, I. C. (2011). Elsevier.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	--	--	--	--	--	--	--	--	3	--
CO2	3	3	--	--	--	--	--	--	--	--	3	--
CO3	3	2	3	3	--	--	--	--	--	--	3	--
CO4	3	3	--	--	--	--	--	--	--	--	3	--
CO5	3	3	3	3	--	--	--	--	--	--	3	--

High-3, Medium-2, Low-1

Semester: VII		
PROCESS INTENSIFICATION (Theory)		
Course Code: MVJ21CH732		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To provide an understanding of the concept of Process Intensification	
2	To provide knowledge and understanding of application of intensification techniques to a range of processes e.g. heat and mass transfer, separation processes	
3	To understand the scientific background, techniques and applications of intensification in the process industries	

UNIT-I	
Introduction: Theory of Process Intensification, Process Intensification (PI) Applications, Main benefits from process intensification, Process-Intensifying equipment, Process intensification toolbox, Techniques for PI application	8 Hrs
UNIT-II	
Process intensification through micro reaction technology: Effect of miniaturization on unit operations and reactions, Design rules, Implementation of Micro reaction Technology, Micro fabrication of reaction and unit operation devices - Scales of mixing Flow patterns in reactors, Mixing in stirred tanks: Scale up of mixing, Heat transfer. Mixing in intensified equipment, Atomizer, Nebulizers	8 Hrs
UNIT-III	
Combined chemical reactor heat exchangers and reactor separators: Principles of operation; Applications, Reactive absorption, Reactive distillation, Applications of RD Processes, Fundamentals of Process Modelling, Reactive Extraction Case Studies: Absorption of NOx Coke Gas Purification	8 Hrs
UNIT-IV	
Compact heat exchangers: classification of compact heat exchangers, plate heat exchangers, spiral heat exchangers, flow pattern, heat transfer and pressure drop, flat tube-and-fin heat exchangers, micro channel heat exchangers, phase-change heat transfer, selection of heat exchanger technology, feed/effluent heat exchangers, integrated heat exchangers in separation processes	8 Hrs
UNIT-V	
Enhanced fields: energy-based intensifications, sonochemistry, basics of cavitation, cavitation reactors, Nusselt flow model and mass transfer, the rotating electrolytic cell, electrostatic fields, sono crystallization,	8 Hrs

supercritical fluids	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concept of Process Intensification and the methodologies for PI
CO2	Explain the benefits of PI in the process industries
CO3	Explain the operating principles of several intensified technologies
CO4	Analyse the range of potential applications of intensified equipment
CO5	Solve process challenges using intensification technologies

Reference Books	
1.	Re-engineering the chemical processing plant: process intensification. Stankiewicz, A., & Moulijn, J. A. (2003). CRC Press.
2.	The fundamentals of process intensification. Sankiewicz, A., Van Gerven, T., & Stefanidis, G. (2019). John Wiley & Sons.
3.	Process Intensification: Engineering for efficiency, sustainability and flexibility.Reay, D., Ramshaw, C., & Harvey, A.(2013). Butterworth-Heinemann.
4.	Process intensification technologies for green chemistry: engineering solutions for sustainable chemical processing. Boodhoo, K., & Harvey, A. (2013). John Wiley & Sons.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
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CO2	3	2	2	--	--	2	2	--	--	--	2	3
CO3	3	2	2	--	--	2	2	--	--	--	2	3
CO4	3	2	2	--	--	2	2	--	--	--	2	3
CO5	3	2	--	--	--	2	2	--	--	--	2	3

High-3, Medium-2, Low-1

Semester: VII		
BIOSENSORS AND BIOELECTRONICS (Theory)		
Course Code: MVJ21CH733		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Understand the significance of Biosensors	
2	Understand the fundamentals and applications of Biosensors	
3	Understand Biosensing Technology and Biomedical applications	

UNIT-I	
Introduction to Biosensors: Definitions, biological inspiration, types of sensors, target analytes, various recognition. Recognition event: Catalytic, Single and multiple enzyme, bioaffinity- labeled and label free, whole cell sensing – bacteria, yeast, mammalian cell. Generation of biosensors. Biomolecule immobilization techniques, enzyme kinetics	8 Hrs
UNIT-II	
Basic Design and Transducer: Considerations calibration, dynamic Range, signal to noise, sensitivity, selectivity, interference. Recognition/Transduction membrane protein sensors- ion channels, types of transducer. Optical fiber- Optic, ECL, surface plasmon resonance, electrochemical Recognition/Transduction membrane protein sensors: ion channels, Types of Transducer, Optical; Fiber Optic, ECL, Surface Plasmon Resonance, Electrochemical; FET, Impedance, Piezoelectric; Cantilever	8 Hrs
UNIT-III	
Applications of Biosensors: Biosensors and diabetes management, Micro fabricated biosensors and point-of-care diagnostics systems, Non-invasive biosensors in clinical analysis; Surface plasmon resonance and evanescent wave biosensors, Biosensor in cancer and HIV early diagnosis	8 Hrs
UNIT-IV	
Applications of Nanomaterials in Biosensors: Nano Materials in biosensors; Carbon based Nano Material, Metal oxide and nano particle, Quantum dots, Role of nano material in Signal Amplifications, Detection and Transducer fabrication	8 Hrs

UNIT-V	
Bioelectronics: Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop insight the basics of biosensing technology.
CO2	Understand the Requisites of basic components and transducer types.
CO3	Develop and Design the biosensor for specific application.
CO4	Understand the concepts Nanomaterials in biosensors.
CO5	Comprehend the gap between the conventional technology and the biosensor and bioelectronics.

Reference Books	
1.	Introduction to biosensors. In Biosensors and bioelectronics, Karunakaran, C., Rajkumar, R., & Bhargava, K. (2015). Elsevier.
2.	Introduction to biosensors. Turner, A. P. F., & Newman, J. D. (1998). Special Publication-Royal Society of Chemistry.
3.	Novel approaches in biosensors and rapid diagnostic assay. Liron, Z., Bromberg, A., & Fisher, M. (2001). Springer Science & Business Media.

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):
Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/P	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1

O	1	2	3	4	5	6	7	8	9	0	1	2
CO1	2	--	--	--	--	--	--	--	--	--	--	--
CO2	2	3	--	--	--	--	--	--	--	--	--	--
CO3	3	3	2	--	--	--	--	--	--	--	--	--
CO4	2	3	2	--	--	--	--	--	--	--	--	--
CO5	2	3	2	--	--	1	--	--	--	--	--	--

High-3, Medium-2, Low-1

Semester: VII		
PROCESS AND INDUSTRIAL SAFETY (Theory)		
Course Code: MVJ21CH734		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40L		SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To know about Industrial safety programs and toxicology, Industrial laws, regulations and source models.	
2	To understand about fire and explosion, preventive methods, relief and its sizing methods.	
3	To analyze industrial hazards and its risk assessment.	

UNIT-I	
Introduction: safety programs, engineering ethics, accident and loss statistics, acceptable risk, public perceptions, nature of the accident process, inherent safety, seven significant disasters. Toxicology: effect of toxicants on biological organisms, toxicological studies, dose versus response, models for dose and response curves, relative toxicity, threshold limit values, national fire protection association (NFPA) diamond.	8 Hrs
UNIT-II	
Government Laws and Regulations, OSHA: process safety management, epa: risk management plan, dhs: chemical facility anti-terrorism standards (CFATS) industrial hygiene: anticipation and identification, evaluation, control. Source Models: introduction to source models, flow of liquid through holes, and pipes, flow of gases or vapors through holes and pipes, flashing liquids, liquid pool evaporation or boiling, conservative analysis.	8 Hrs
UNIT-III	
Fires and Explosions: the fire triangle, distinction between fires and explosions, definitions, flammability characteristics of liquids and vapors, limiting oxygen concentration and inserting, flammability diagram, ignition energy, auto-ignition, auto-oxidation, adiabatic compression, ignition sources, sprays and mists, explosions .Concepts to prevent fires and explosions: inserting, static electricity and its control, explosion-proof equipment and instruments, ventilation, sprinkler systems, miscellaneous concepts for preventing fires and explosions.	8 Hrs
UNIT-IV	
Introduction to Reliefs: relief concepts, definitions, location of reliefs, relief types and characteristics, relief scenarios, data for sizing reliefs, relief systems. relief sizing : conventional spring-operated reliefs in liquid and in vapor or gas services, rupture disc reliefs in liquid in vapor or gas services, two-phase flow during runaway reaction relief, pilot-	8 Hrs

operated and bucking-pin reliefs, deflagration venting for dust and vapor explosions, venting for fires external to process vessels, reliefs for thermal expansion of process fluids.	
UNIT-V	
Hazards Identification: process hazards checklists, hazards surveys, hazards and operability studies, safety reviews, other methods, risk assessment: review of probability theory, event trees, fault trees, QRA and LOPA	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyse the effect of release of toxic substances.
CO2	Understand the industrial laws, regulations, and source models and also responsible for minimising the accidents in work environment.
CO3	Apply the methods of prevention of fire and explosions.
CO4	Understand the relief and its sizing methods.
CO5	Understand the methods of hazard identification and preventive measures.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	1	--	--	--	--	--	--	--	--	--	1
CO2	2	1	--	--	--	--	--	--	--	--	--	1
CO3	2	1	--	--	--	--	--	--	--	--	--	1
CO4	2	1	--	--	--	--	--	--	--	--	--	1
CO5	2	1	--	--	--	--	--	--	--	--	--	1

High-3, Medium-2, Low-1

Semester: VII		
ENERGY TECHNOLOGY (Theory)		
Course Code: MVJ21CH741		CIE Marks:50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L+26T		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To enhance knowledge and skills in the areas of importance of pollution, analysis & treatment of wastewater, polluted air, solid waste, noise and its control.	
2	Understand Concepts of nonconventional energy sources and allied technology required for energy conversion	
3	Understand the general classification of energy.	
4	Get insight into the Energy Conservation.	
5	Assess different methodologies for energy audit.	

UNIT-I	
Introduction to energy – Global energy scene, Indian energy scene, units of energy, conversion factors, a general classification of energy, energy crisis, energy alternatives.	8 Hrs
UNIT-II	
Conventional energy resources, thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.	8 Hrs
UNIT-III	
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, the economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.	8 Hrs
UNIT-IV	
Biomass origin – resources, biomass estimation. Thermochemical conversion – biological conversion, chemical conversion – hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.	8 Hrs
UNIT-V	
Energy conservation – Act; energy management importance, duties and responsibilities. Energy audit – types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the general classification of energy and discuss on energy crisis and identification of energy alternatives.
CO2	Understand conventional energy sources and to study on power plants.
CO3	Outline the non-conventional energies.
CO4	Explain the resources, estimation, and generation of biomass.
CO5	Learn the energy conservation in process industries.

Reference Books	
1.	Energy Technology, Rao, S. and Parulekar, B.B, second edition, 2005, Khanna Publishers.978-81-7409-040-9
2.	Power Plant Engineering, Nagpal, G.R.,16th edition, 2008, Khanna Publishers.ISBN:978-81-7409-309-7
3.	Non-conventional Energy Sources, Rai, G.D., sixth edition,1984, Khanna Publishers, New Delhi.ISBN:978-81-7409-073-7
4.	Solar Energy – Thermal Collection and Storage, Sukhatme. S.P., sixth edition, 1981, Tata McGraw hill, New Delhi,

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of Cos and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12

CO1	2	1	--	--	2	--	--	--	--	--	--	1
CO2	2	1	--	--	2	--	--	--	--	--	--	1
CO3	2	1	--	--	2	--	--	--	--	--	--	--
CO4	2	1	--	--	2	--	--	--	--	--	--	--
CO5	2	1	--	--	2	--	--	--	--	--	--	1

High-3, Medium-2, Low-1

Semester: VII		
ISO & QUALITY MANAGEMENT SYSTEM (Theory)		
Course Code: MVJ21CH742		CIE Marks: 50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L+26T		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To formulate new plans/procedures to be implemented to achieve the desired quality status by knowing about the various principles of quality management.	
2	By understanding various quality terms, it will be helpful for the student to maintain quality in his/her organization.	
3	The student will be able to analyze the periodical data in quality control using statistical tools.	
4	The total quality management tools will help the student to understand the procedures in measuring the quality of the organization/process and will also enable him/her to identify the parameters that are improving/depriving the quality.	
5	By knowing about the quality ISO systems, the student will maintain processes/documentation properly so that the quality maintained by his/her organization gets recognized.	

UNIT-I	
Introduction: need for quality, evolution of quality, definition of quality dimensions of manufacturing and service quality, basic concepts of TQM definition of TQM, TQM framework - contributions of deming, juran and cross by – barriers to TQM.	8 Hrs
UNIT-II	
TQM Principles: leadership strategic quality planning, quality statements customer focus customer orientation, customer satisfaction, customer complaints, customer retention - employee involvement motivation, empowerment, team and teamwork, recognition and reward, performance appraisal, continuous process improvement, PDSA cycle, 5s, Kaizen - Supplier partnership, partnering, Supplier selection, Supplier rating.	8 Hrs
UNIT-III	
TQM Tools and Techniques-I: the seven traditional tools of quality, new management tools, six-sigma: concepts, methodology, applications to manufacturing, service sector including it, bench marking, reason to benchmark, bench marking process – FMEA – Stages and types.	8 Hrs
UNIT-IV	
TQM Tools and Techniques-II: Quality circles, Quality Function Deployment (QFD), Taguchi quality loss function, TPM, concepts, improvement needs, cost of Quality, Performance measures.	8 Hrs
UNIT-V	

Quality Systems: Need for ISO 9000- ISO 9000-2000 Quality System elements, Documentation, quality auditing, QS 9000 – ISO 14000, concepts, requirements and benefits, case studies of TQM implementation in manufacturing and service sectors including IT.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	An ability to design and conduct experiments, as well as to analyze and interpret data.
CO2	An ability to function on multidisciplinary teams.
CO3	An understanding of professional and ethical responsibility.
CO4	An ability to communicate effectively.
CO5	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Reference Books	
1.	Total Quality Management, Bhat. S.K first edition, 2002. Text and Cases, Himalaya Publishing House.
2.	The Management and Control of Quality, James R. E. and William M. L. sixth edition (2005). South-Western Thomson Learning.
3.	TQM – Text with Cases, Oakland, J.S. third edition, 2003, Butterworth – Heinemann Ltd. Oxford.
4.	Total Quality Management, Suganthi,L and Anand Samuel, (2006)., Prentice Hall (India) Pvt. Ltd

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

Semester: VII		
MATERIAL SCIENCE AND TECHNOLOGY (Theory)		
Course Code: MVJ21CH743		CIE Marks:50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L+26T		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To make the students understand the basics of crystallography and its importance in studying materials properties.	
2	To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.	
3	To instill knowledge on characterization of materials for various applications in material science.	
4	To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications.	
5	To inculcate an idea of significance of biomaterials and polymers used in biomedical applications.	

UNIT-I	
Introduction to Material Science: Introduction and structure of materials, why study properties of materials, Structure of atoms – quantum states, atomic bonding in solids, binding energy interatomic spacing, variation in bonding characteristics – single crystals polycrystalline, Non-crystalline solids, Imperfection in solids, Vacancies, Interstitials geometry of dislocation, Schmid´s law, Surface imperfection, Importance of defects, Microscopic techniques – grain size distribution.	8 Hrs
UNIT-II	
Electrical and Magnetic properties of Materials: Classical free electron theory – expression for electrical conductivity, Thermal conductivity, expression, Quantum free electron theory : Tunneling, degenerate states – Fermi- Dirac statistics, Density of energy states, Electron in periodic potential ,Energy bands in solids, tight binding approximation – Electron effective mass , concept of hole. Magnetic materials: Dia, para and ferromagnetic effects, paramagnetism in the conduction electrons in metals, exchange interaction and ferromagnetism, quantum interference devices – GMR devices.	8 Hrs
UNIT-III	
Characterization of Materials: Principle, theory, working and application; X-Ray diffraction, X-Ray reflectivity, Scanning electron microscopy, Transmission electron microscopy, High resolution transmission electron microscopy, Field emission scanning electron microscopy, Atomic force microscopy, Scanning tunnelling spectroscopy / microscopy, photoluminescence spectroscopy, Electrochemical	8 Hrs

impedance spectroscopy, polarized neutron reflectivity, differential thermal and gravimetric analysis, dynamic mechanical analysis, Universal testing machine, vibrating sample magnetometer, Vector network analyzer, vibrating sample magnetometer, Brunauer-Emmett Teller surface areas, Zeta sizer, environmental mode.	
UNIT-IV	
Optical Properties of Materials: Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode – optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.	8 Hrs
UNIT-V	
Polymers and Biomaterials: Natural polymers: chemical & physical structure, properties, source, Important chemical modifications, Applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins etc. Molecular weight and its distribution determination (Mn to Mz& MWD), Carothers equation, States of polymers, Transition temperatures such as Tg, Tc, Tm, Solubility parameter, Solution properties, Temperature, Good/ bad solvent. Introduction to biomaterials for biomedical applications, Chemical structure and property of biomaterials, Degradation of biomaterials.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	To know the basics of crystallography and its importance for varied materials. Properties.
CO2	To gain knowledge on the electrical and magnetic properties of materials and their applications.
CO3	To understand clearly the techniques used in material characterization.
CO4	To understand the optical properties of materials and working principles of various optical devices.
CO5	To appreciate the importance of materials used in biomedical applications.

Reference Books	
1.	Materials Science and Engineering: A First Course, Raghavan V. sixth edition, 2015., Prentice Hall India Learning Private Limited ISBN:978-81-203-5092-2
2.	Principles of Electronic Materials and Devices, Kasap. S.O. second edition, 2018, Mc-Graw Hill.
3.	Semiconductor Optoelectronics: Physics and Technology, Jasprit Singh first edition, 2019, Mc-Graw Hill India
4.	Elements of X-ray Diffraction, Cullity B.D., fourth edition, 1978, Addison Wiley.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

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CO-PO Mapping												
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	1		--	--	--	--	--	--	--	--	2
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CO3	2	1	--	--	--	--	--	--	--	--	--	2
CO4	2	1	--	--	--	--	--	--	--	--	--	2
CO5	2	1	--	--	--	--	--	--	--	--	--	2

High-3, Medium-2, Low-1

Semester: VII		
PROCESS & INDUSTRIAL SAFETY (Theory)		
Course Code: MVJ21CH744		CIE Marks:50
Credits: L:T:P:3:0:0		SEE Marks: 50
Hours: 40L+26T		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To know about Industrial safety programs and toxicology, Industrial laws, regulations, and source models.	
2	To understand about fire and explosion, preventive methods, relief and its sizing methods.	
3	To analyze industrial hazards and its risk assessment.	
4	Relate safety, economics and human factors.	
5	Carry out risk assessment in process industries.	

UNIT-I	
Introduction: safety programs, engineering ethics, accident and loss statistics, acceptable risk, public perceptions, nature of the accident process, inherent safety, seven significant disasters. Toxicology: effect of toxicants on biological organisms, toxicological studies, dose versus response, models for dose and response curves, relative toxicity, threshold limit values, national fire protection association (NFPA) diamond.	8 Hrs
UNIT-II	
Government Laws and Regulations, OSHA: process safety management, EPA: risk management plan, DHS: chemical facility anti-terrorism standards (CFATS) industrial hygiene: anticipation and identification, evaluation, control. Source Models: introduction to source models, flow of liquid through holes, and pipes, flow of gases or vapors through holes and pipes, flashing liquids, liquid pool evaporation or boiling, conservative analysis.	8 Hrs
UNIT-III	
Fires and Explosions: the fire triangle, distinction between fires and explosions, definitions, flammability characteristics of liquids and vapors, limiting oxygen concentration and inserting, flammability diagram, ignition energy, auto-ignition, auto-oxidation, adiabatic compression, ignition sources, sprays and mists, explosions. Concepts to prevent fires and explosions: inserting, static electricity and its control, explosion-proof equipment and instruments, ventilation, sprinkler systems, miscellaneous concepts for preventing fires and explosions.	8 Hrs
UNIT-IV	
Introduction to Reliefs: relief concepts, definitions, location of reliefs, relief types and characteristics, relief scenarios, data for sizing reliefs,	8 Hrs

relief systems. relief sizing : conventional spring-operated reliefs in liquid and in vapor or gas services, rupture disc reliefs in liquid in vapor or gas services, two-phase flow during runaway reaction relief, pilot-operated and bucking-pin reliefs, deflagration venting for dust and vapor explosions, venting for fires external to process vessels, reliefs for thermal expansion of process fluids.	
UNIT-V	
Hazards Identification: process hazards checklists, hazards surveys, hazards and operability studies, safety reviews, other methods, risk assessment: review of probability theory, event trees, fault trees, QRA and LOPA	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyse the effect of release of toxic substances.
CO2	Understand the industrial laws, regulations, and source models and also responsible for minimizing the accidents in work environment.
CO3	Apply the methods of prevention of fire and explosions.
CO4	Understand the relief and its sizing methods.
CO5	Understand the methods of hazard identification and preventive measures.

Reference Books	
1.	Chemical Process Safety (Fundamentals with Applications), Crowl D.A. and Louvar J.F. 2011., Prentice Hall.
2.	Fundamentals of Industrial safety & health, Mistry.K.U.(2012) (3rd edn.), Volume 1 and 2, Siddarth Publishers
3.	Chemical Engineering, Sinnott R.K. Coulson & Richardson (2006), Vol. 6. Elsevier India
4.	Safety and accident prevention in Chemical operations (2nd ed.), Fawcett H.H. and Wood W.S. (1982).. John Wiley and Sons Inc

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

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Semester End Examination (SEE):
Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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CO1	2	1	--	--	--	--	--	--	--	--	--	1
CO2	2	1	--	--	--	--	--	--	--	--	--	1
CO3	2	1	--	--	--	--	--	--	--	--	--	1
CO4	2	1	--	--	--	--	--	--	--	--	--	1
CO5	2	1	--	--	--	--	--	--	--	--	--	1

High-3, Medium-2, Low-1