Semester: III		
FOURIER SERIES, TRANSFORMS, NUMERICAL AND OPTIMIZATIONTECHNIQUES		
Course Code:	**MVJ21MA31C**	**CIE Marks:50**
Credits: L:T:P:	**3:2:0**	**SEE Marks: 50**
Hours:	**50L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Solve the linear differential equations using Laplace transforms.	
2	Apprehend and apply Fourier transform.	
3	Demonstrate Fourier Transform as a tool for solving Integral equations.	
4	Solve initial value problems using appropriate numerical methods.	
5	Students learn to linear programming problems in civil and chemical engineering.	

UNIT-I	
Laplace Transforms: Definition, Transforms of elementary functions, Properties, Periodic function, Unit step function, Unit impulse function– problems. Inverse Laplace Transforms: Inverse Laplace Transforms, Convolution theorem to find inverse Laplace transform. Solution of linear differential equations using Laplace transforms **Self study:** Solution of simultaneous first order differential equations **Applications:** Analysis of electrical and electronic circuits, used in Signal processing and in control systems.	**10 Hrs**
UNIT-II	
Fourier Series: Periodic functions, Dirichlet's condition, Fourier series of periodic functions with period 2π and arbitrary period $2c$. Fourier series of even and odd functions. Half range Fourier Series, Complex form of Fourier series Practical harmonic Analysis and Problems. **Self study:** Complex form of Fourier series. **Applications**: The Fourier series has many such applications in harmonic analysis, vibration analysis,acoustics, optics etc.	**10 Hrs**
UNIT-III	
Fourier transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse Fourier sine and cosine transforms, Convolution theorem for Fourier transform. **Self study:** Convolution theorem for Fourier transform **Applications:** Fourier Transformation (FT) has huge application in studying to study vibrations in building/structures. Any kind of spectroscopy applied in chemical engineering (CE) is based in Fourier techniques.	**10 Hrs**
UNIT-IV	
Numerical solution of ordinary differential equations: Numerical solution of first order and first degree; Taylor's series method, modified Euler's method, Runge-Kutta method of fourth-order. Differential Equations of second order: Runge-Kutta method and Milne's Predictor and Corrector method. Self study: Adams- Bash forth predictor and corrector methods	**10 Hrs**

Applications: Numerical Methods are used to provide „approximate" results for the differential equation problems being dealt with and their necessity is felt when it becomes impossible or extremely difficult to solve a given problem analytically.	
UNIT-V	
Optimization Techniques: Linear Programming, Mathematical formulation of linear programming problem (LPP), Graphical Method, Simplex Method, Dual simplex methods and Big M methods. **Self study:** Two phase simplex methods**.** **Applications:** Linear Programming is used in a variety of fields including food and agriculture, engineering,transportation problems, manufacturing and energy.	**10 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Use Laplace transform and inverse transforms techniques in solving differential equations.
CO2	Know the use of periodic signals and Fourier series to analyze circuits and system.
CO3	Demonstrate Fourier Transform as a tool for solving Integral equations.
CO4	Identify appropriate numerical methods to solve ODE.
CO5	Solve the mathematical formulation of linear programming problem.

Reference Books	
1.	Higher Engineering Mathematics, B.S. Grewal, 2013, 44th Edition, Khanna Publishers.
2.	Advanced Engineering Mathematics, Erwin Kreyszig, 2014, 10th edition, Wiley-India publishers.
3.	Engineering Mathematics-III, Prof G.B.Gururajachar, 2016-17, Academic Excellent series Publications.
4.	Higher Engineering Mathematics, Ramana B. V., Tata McGraw-Hill, 2006.

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	**3**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**--**
CO2	**3**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO3	**2**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**--**
CO4	**3**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**

High-3, Medium-2, Low-1

Semester: III		
CHEMICAL PROCESS CALCULATIONS (Theory)		
Course Code:	**MVJ21CH32**	**CIE Marks:50**
Credits: L:T:P:	**3:2:0**	**SEE Marks: 50**
Hours:	**40L, 26T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
Convert units from one system to the other.		
Make material balances for unit operations and processes.		
Make material balances for systems with bypass, recycle and recycle with purge		
Calculate the adiabatic reaction temperatures/ theoretical flame temperatures		

UNIT-I	
Units and Dimensions: Fundamental and derived units, inter conversion of units from one system to another (FPS, CGS, MKS, SI).Conversion of equations. **Basic Chemical Calculations:** Concept of mole. Expressions for composition of mixtures of solids, liquids and gases, percentage by weight, mole and volume. Composition of mixtures and solutions- Normality, Molarity, Molality and ppm. Concentration scales based on specific gravity-Baume, Twaddle, Brix and API gravity scales.	**10 Hrs**
UNIT-II	
Ideal gases- Gas laws, mole volume relation, effect of temperature on volume of gases. Gas laws for mixtures. Average molecular weight, density and specific gravity of gas mixtures. **Vapor Pressure:** Definition of vapor pressure, partial pressure, relative saturation % saturation, humidity, molal humidity, relative humidity, % humidity, Psychrometry. Simple problems solving using psychrometric charts. Evaporation and condensation processes.	**10 Hrs**
UNIT-III	
Introduction to material balances: Material balance without reactions, General methods of solving problems. Material balance for unit operations like mixing, Distillation, extraction, crystallization, evaporation, drying, absorption, leaching.	**10 Hrs**
UNIT-IV	
Steady-state material balance with reaction: Principles of stoichiometry, Concept of limiting and excess reactants, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems. Fuels and combustion-ultimate and proximate analysis of fuels, Material balances with and without reactions involving bypass, recycle and purging.	**10 Hrs**
UNIT-V	
Energy Balance: General energy balance equation for steady state. Thermo chemistry, heat capacity, estimation of heat capacity for solids, liquids, gases and	**10 Hrs**

their mixtures. Standard heat of formation, standard heat of reaction, standard Heat of combustion, and calorific value of fuels. Calculation of $\triangle$HR at elevated temperatures. Adiabatic reaction temperature and adiabatic flame temperature and their calculations.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend the basic theories in stoichiometry and perform unit conversions and calculations.
CO2	To understand the basic calculations of air water system and calculate various quantities related to air water system
CO3	Solve material balance problems of steady state unit operation like drying, mixing, evaporation, distillation, extraction, crystallization, absorption and leaching
CO4	To understand chemical engineering calculation and solve material balance problems with reactions including bypass and recycling
CO5	Explain the concepts of thermo chemistry and solve steady-state enthalpy balance problems.

Reference Books	
1	Chemical Processes Principles. Part I: Material and Energy Balances, Hougen, O. A., Watson, K. M., & Ragatz, R. A. (1962), John Wiley and Sons.
2	Basic principles and calculations in chemical engineering, Himmelblau, D. M., & Riggs, J. B., (2012), FT press.
3.	Stoichiometry, Bhatt, B. I., & Thakore, S. B. (2010), Tata McGraw-Hill Education.
4	Elementary principles of chemical processes, Felder, R. M., Rousseau, R. W., & Bullard, L. G. (2020), 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												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**1**
CO2	**3**	**3**	**3**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**3**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**3**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**1**
CO5	**3**	**3**	**3**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: III		
MATERIAL SCIENCE FOR CHEMICAL ENGINEERS (Theory)		
Course Code:	**MVJ21CH33**	**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 understand concepts on properties and selection of metals, ceramics, and polymers for design and Manufacturing.	
2	To identify the phase transformation that can be adopted to predict the various crystal structure of metals	
3	To determine Young's modulus of elasticity of the material of a given wire and heat treatment process	
4	To Study detailed information on types of corrosion and its prevention.	
5	To select the material of construction in automotive, structural, failure analysis and other types of industries	

UNIT-I	
Introduction: Engineering Materials – Classification – levels of structure, structure property relationships in materials. **Crystal Geometry and Structure Determination:** Geometry of crystals – the Bravais lattices, Crystal directions and planes – the miller indices, Structure determination – X –Ray diffraction- Bragg law, the powder method, Electron diffraction &Neutron diffraction. **Atomic structure and Chemical bonding & Structure of solids:** Periodic table, Ionization potential, Electron affinity and Electro-negativity, Correlation between Bonding and the Properties of Solids (Ionic, molecular, covalent, metallic solids)	**8 Hrs**
UNIT-II	
Crystal Imperfection: Point Imperfections, Line imperfections – edge and screw dislocations, the Burgers vector, line energy of dislocations, Surface imperfections **Basic thermodynamic functions:** phase diagrams and phase transformation: Single component systems, Binary phase diagrams, Lever rule, typical phase diagrams for Magnesia-Alumina, Copper – Zinc, iron – carbon systems, Nucleation and growth. Solidification, Allotropic transformation	**8 Hrs**
UNIT-III	
Deformation of Materials and Fracture: Elastic deformation, Plastic deformation, Visco-elastic deformation, Stress and strain curve for ductile & brittle material, creep, Different types of fracture. Heat Treatment: Annealing, Normalizing Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Furnace types.	**8 Hrs**
UNIT-IV	
Corrosion and its Prevention: corrosion and its manifestations, consequences, direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature	**8 Hrs**

corrosion, Passivity, factors influencing corrosion rate, control and prevention of corrosion-modification of corrosive environment, inhibitors, protective coatings, Specific types of corrosion	
UNIT-V	
Typical Engineering materials: Ferrous metals, non-ferrous metals and alloys, Aluminium and its alloys, Copper and its alloy, Lead and its alloy, Tin, Zinc and its alloy, silicon and its alloys**,** Alloys for high temperature service, Ceramic materials- structure of ceramics, polymorphism, Mechanical, electrical and thermal properties of ceramics phases, Refractories, Glasses, abrasives, plastics, fibes, and elastomers, Organic protective coating.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Classify different types of engineering materials depending on structure property, crystal geometry and X-Ray diffraction, atomic structures, types of bonding.
CO2	Explain crystal imperfections and. draw phase diagrams of different metals, TTT curves.
CO3	Enumerate deformation of materials and suggest different type of heat treatment techniques depending on the type of the material.
CO4	Interpret different types of corrosions and suggest preventive methods
CO5	Select materials depending on type of application.

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

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**	**1**		**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO2	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO3	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO4	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO5	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**

High-3, Medium-2, Low-1

Semester: III		
MECHANICAL OPERATIONS (Theory and Practice)		
Course Code:	**MVJ21CH34**	**CIE Marks:50+50**
Credits: L:T:P:	**2:2:2**	**SEE Marks: 50 +50**
Hours:	**40 L+26P**	**SEE Duration: 03+03 Hrs**
Course Learning Objectives: The students will be able to		
1	Study different properties of particulate solids.	
2	Study principles of comminution and different types of equipment for size reduction like crushers.	
3	Understand mechanical separation aspect such as screening.	
4	Understand energy requirements in solids handling.	

UNIT-I	
Particle Technology: particle shape, particle size, different ways of expression of particle size, shape factor, sphericity, particle size analysis; screens – ideal and actual screens, Tyler series, differential and cumulative size analysis, effectiveness of screen, specific surface of a mixture of particles, number of particles in a mixture, standard screens, motion of screen; industrial screening equipment- Grizzly, Gyratory screen, Vibrating screen, Trommels, sub sieve analysis – air permeability test, air elutriation, beaker decantation.	**8 Hrs**
UNIT-II	
Size Reduction: Introduction – types of forces used for comminution, criteria for comminution, characteristics of comminute products, laws of size reduction, work index, energy utilization, methods of operating crushers – free crushing, choke feeding, open circuit grinding, closed circuit grinding, wet and dry grinding; equipment for size reduction – classification of size reduction equipment; equipment – blake jaw crusher, gyratory crusher, smooth roll crusher, toothed roll crusher, impactor, ball mill, critical speed of ball mill; cutters – knife cutter, ultrafine grinder-fluid energy mill, colloid mill.	**8 Hrs**
UNIT-III	
Filtration: Introduction, classification of filtration, cake filtration, clarification, batch, and continuous filtration, pressure and vacuum filtration, derivation of constant rate filtration and constant pressure filtration, characteristics of filter media; industrial filters-sand filter, filter press, leaf filter, rotary drum filter; principles of centrifugal filtration, Rate of washing – suspended batch centrifuge, filter aids, application of filter aids.	**8 Hrs**
UNIT-IV	
The motion of particles through fluids: mechanics of particle motion, the equation for one-dimensional motion of particles through a fluid in the gravitational and centrifugal field, terminal velocity, motion of spherical particles in Stokes's region, newton's region, and intermediate region, the criterion for settling regime, hindered settling, modification of equation for hindered settling.	**8 Hrs**

Sedimentation: Batch settling test, Coe and Clevenger theory, Kynch theory, thickener design, Equipment: Gravity Settling Tank, Disk Bowl Centrifuge.	
UNIT-V	
Agitation and mixing: application of agitation, agitation equipment, types of impellers – propellers, paddles and turbines, flow patterns in agitated vessels, prevention of swirling, standard turbine design, power correlation and power calculation, mixing of solids, mixing index, types of mixers –, muller mixers, mixing index, ribbon blender, internal screw mixer. **Sampling, storage and conveying of solids:** sampling of solids, storage of solids, open and closed storage, bulk and bin storage, conveyors – belt conveyers, chain conveyor, apron conveyor, bucket conveyor, screw conveyor. **Miscellaneous separation:** centrifugal separators: cyclones and hydro cyclones, magnetic separation, electrostatic separation.	**8 Hrs**

LABORATORY EXPERIMENTS
1. Ball mill- verify the crushing laws using given sample
2. Batch sedimentation- determine area of thickener required for given sample
3. Free settling- determine settling velocity of various samples
4. Drop weight crusher- verify the crushing laws using given sample
5. Sieve analysis-find the particle size distribution of the given sample
6. Screen effectiveness-find the separation efficiency of given screen
7. Jaw crusher- verify the crushing laws using given sample
8. Leaf filter-find the specific cake resistance
9. Grindability index
10. Froth floatation- Efficiency of frothing agent in separating given ore sample
11. Plate and frame filter press - find the specific cake resistance
12. Cyclone separator- Efficiency of separation
Any 10 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Study different properties of particulate solids, handling and mixing of solid particles.
CO2	Study principles of comminution and different types of equipment for size reduction like crushers, grinders etc.
CO3	Derive the expression to find rate of filtration for various types of filtrations and to study the working of various filtration equipment's.
CO4	Explain the phenomenon of motion of particles through fluids in various flow fields and regimes, Outline the various theories of Sedimentation in designing industrial thickeners.
CO5	Explain various miscellaneous separation processes and illustrates the working principle of agitation and mixing and describe the sampling of solid and conveying of it.

Reference Books

1.	McCabe, W. L., Smith, J. C., & Harriott, P. (1993). Unit Operations of Chemical Engineering. 7th ed. McGraw-hill.
2.	Badger, W. L., & Banchero, J. L. (2010). Introduction to Chemical Engineering. 4th ed. McGraw-hill.
3.	Richardson J.F., Coulson J.M, Backhurst J.R, and Harker J.H. (2002). 5th ed. Particle Technology and Separation Processes. Elsevier.
4.	Brown G.G, (2018). Unit Operations. CBS Publisher.

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.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: III		
MOMENTUM TRANSFER (Theory and Practice)		
Course Code:	**MVJ21CH 35**	**CIE Marks:50+50**
Credits: L:T:P:	**2:2:2**	**SEE Marks: 50 +50**
Hours:	**40 L+26P**	**SEE Duration: 03+03 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand concepts on nature of fluids, type of fluid flow and boundary layer relations, pressure concepts and its measurement by various experimental methods, and enhancement of problem-solving skills.	
2	Understand the relationship between kinetic energy, potential energy, internal energy, and work complex flow systems using Bernoulli's equation with application to industrial problems.	
3	Understand clear concepts on Flow of compressible and incompressible fluids in conduits and thin layers and friction factor variations with velocity and friction losses using Bernoulli's Equations and they will be demonstrated experimentally.	
4	Study Dimensional analysis and working of pumps, transportation, and metering of fluids using various techniques and applications to industry.	

UNIT-I	
Fluid statics and its applications – the concept of unit operations; introduction to momentum transfer, nature of fluids and pressure concept, variation of pressure with height – hydrostatic equilibrium, barometric equation; measurement of fluid pressure – manometers, continuous gravity decanter, centrifugal decanter. Fluid flow phenomena –the type of fluids; shear stress and velocity gradient relation, newtonian and non- newtonian fluids, the viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Reynolds stress, eddy viscosity; flow in boundary layers; Reynolds number, boundary layer separation, and wake formation.	**8 Hrs**
UNIT-II	
Basic equations of fluid flow -average velocity, mass velocity, continuity equation, Euler, and Bernoulli equations; modified equations for real fluids with correction factors; pump work in Bernoulli equation, angular momentum equation. The flow of incompressible fluids in conduits and thin layers - laminar flow through circular and non-circular conduits, Hagen Poiseuille equation, laminar flow of non-newtonian liquids, turbulent flow in pipes and closed channels.	**8 Hrs**
UNIT-III	
The flow of incompressible fluids in conduits and thin layers (contd...) - friction factor chart, friction from changes in velocity or direction, form friction losses in Bernoulli equation, flow of fluids in thin layers The flow of compressible fluids - continuity equation,Mach number, total energy balance, the velocity of sound, Ideal gas equations, flow through variable-area	**8 Hrs**

conduits, adiabatic frictional flow, isothermal frictional flow (elementary treatment only).	
UNIT-IV	
Transportation and metering of fluids - pipes, fittings, and valves; flow measuring devices - venturi meter, orifice meter, rotameter, and pitot tube; the elementary concept of target meter, vortex-shedding meters, turbine meters, positive displacement meters, magnetic meters, Coriolis meters, and thermal meters; flow through open channel-weirs and notches; performance and characteristics of pumps-positive displacement and centrifugal pumps, fans, compressors, and blowers.	**8 Hrs**
UNIT-V	
Flow of fluid past immersed bodies: Drag, drag coefficient, Pressure drop – Kozeny-Carman equation, Blake-Plummer, Ergun equation, Fluidization, conditions for fluidization, Minimum fluidization velocity, Pneumatic conveying, Industrial application of Fluidization. Dimensional analysis: Dimensional homogeneity, Rayleigh's, and Buckingham Π-methods, Significance of different dimensionless numbers.	**8 Hrs**
LABORATORY EXPERIMENTS	
1. Friction in circular pipes. 2. Friction in non-circular pipes. 3. Friction in helical/spiral coils. 4. Flow measurement using venturi (incompressible fluid). 5. Flow measurement using orifice meters (incompressible fluid). 6. Flow over notches - find the coefficient of discharge through various notches. 7. Flow over rectangular notches- generalized correlation between Reynold's number & friction factor 8. Flow through open orifice-Hydraulic coefficients. 9. Flow through Packed bed-Verify ERGUN'S Equation 10. Flow through Fluidized bed- to calculate the minimum fluidization velocity 11. Study of characteristics for centrifugal, Positive displacement pump 12. Study of various pipe fittings and their equivalent lengths. 13. Unsteady flows - Emptying of Tank **Any 12 experiments to be conducted**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the concepts of fluid statics and dynamics to measure pressure and differentiate various flow phenomena.
CO2	Derive the fundamental equations and apply to solve various fluid flow problems.
CO3	Understand the various equations for incompressible and compressible fluids in conduits.
CO4	Demonstrate the knowledge of fluid flow principles in various types of flow measurements, transportation and metering of fluids using experimental techniques and applications to industry.

CO5	Develop functional relationships using dimensional analysis and similitude to solve technical problems also to analyse the flow past immersed bodies.

Reference Books	
1.	Unit operations of chemical engineering, McCabe, W. L., Smith, J. C., & Harriott, P., 2005, New York: McGraw-hill, ISBN: 9780071247108, 0071247106
2.	A textbook of fluid mechanics, Bansal, R. K., 2005, Laxmi Publication (P) Ltd.
3.	Engineering fluid mechanics, Kumar, K. L., 4th edn, 1988, New Delhi: Eurasia.
4.	Chemical Engineering, Coulson J.H. and Richardson J.F., 1998. Vol-I, 5^{th}edn.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Laboratory- 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

CO4	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO5	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: III		
AEC3: SOFT SKILLS FOR ENGINEERS (Theory)		
Course Code:	**MVJ21CH37**	**CIE Marks: 50**
Credits: L:T:P:	**1:0:2**	**SEE Marks: 50**
Hours:	**25L**	**SEE Duration: 3 Hrs.**

Course Learning Objectives: The students will be able to	
1	To encourage all round development of the students by focusing on soft skills
2	To make the students aware of critical thinking and problem-solving skills
3	To develop leadership skills and organizational skills through group activities
4	To function effectively with heterogeneous teams

UNIT-I	
Introduction, meaning, significance of soft skills –definition, significance, types of communication skills -Intrapersonal & Inter-personal skills -Verbal and Non-verbal Communication	**5 Hrs**
UNIT-II	
Active Listening –Observation –Curiosity –Introspection –Analytical Thinking – Open-mindedness –Creative Thinking	**5 Hrs**
UNIT-III	
Meaning & features of Problem Solving –Managing Conflict –Conflict resolution – Methods of decision making –Effective decision making in teams –Methods & Styles	**5 Hrs**
UNIT-IV	
Managing Emotions –Thinking before Reacting –Empathy for Others –Self-awareness –Self-Regulation –Stress factors –Controlling Stress –Tips	**5 Hrs**
UNIT-V	
Team-Building –Decision-Making –Accountability –Planning –Public Speaking – Motivation –Risk-Taking -Team Building -Time Management	**5 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Memorize various elements of effective communicative skills.
CO2	Interpret people at the emotional level through emotional intelligence.
CO3	Apply critical thinking skills in problem solving.
CO4	Analyse the needs of an organization for team building.
CO5	Judge the situation and take necessary decisions as a leader and develop social and work-life skills as well as personal and emotional well-being.

Reference Books	
1.	Personality Development and Soft Skills, Mitra Barun K., 2012, Publisher: Oxford University Press

2.	Personality Development and Soft Skills: Preparing for Tomorrow, Shikha Kapoor, 2018, I K International Publishing House.
3.	Soft Skills: An Integrated Approach to Maximise Personality, Gajendra Singh Chauhan, Sangeetha Sharma, 2015, Wiley.

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**	**1**	--	--	--	--	--	--	--	--	--	--
CO2	**2**	**1**	--	--	--	--	--	--	--	--	--	--
CO3	**2**	**1**	--	--	--	--	--	--	--	--	--	--
CO4	**2**	**1**	--	--	--	--	--	--	--	--	--	--
CO5	**2**	**1**	--	--	--	--	--	--	--	--	--	--

High-3, Medium-2, Low-1

Semester: III		
ADDITIONAL MATHEMATICS-I (Common to all branches)		
Course Code:	**MVJ21MATDIP-I**	**CIE Marks:50**
Credits: L:T:P:	**1:2:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	To familiarize the important and introductory concepts of Differential calculus.
2	Aims to provide essential concepts integral calculus.
3	To gain knowledge of vector differentiation.
4	To learn basic study of probability.
5	Ordinary differential equations of first order and analyze the engineering problems.

UNIT-I	
Differential calculus: Recapitulation of successive differentiation -nth derivative - Leibnitz theorem (without proof) and Problems, Polar curves - angle between the radius vector and tangent, angle between two curves, pedal equation, Taylor's and Maclaurin's series expansions- Illustrative examples.	**8 Hrs**
UNIT-II	
Integral Calculus: Statement of reduction formulae for the integrals of $\sin^n(x)$, $\cos^n(x)$, $\sin^n(x)\cos^n(n)$ and evaluation of these integrals with standard limits-problems. Double and triple integrals-Simple examples.	**8 Hrs**
UNIT-III	
Vector Differentiation: Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. **Vector identities** - $div(\phi\vec{A})$, $curl(\phi\vec{A})$, $curl(grad(\phi))$, $div(curl\,\vec{A})$.	**8 Hrs**
UNIT-IV	
Probability: Basic terminology, Sample space and events. Axioms of probability. Conditional probability – illustrative examples. Bayes theorem-examples.	**8 Hrs**
UNIT-V	
Ordinary Differential Equations of First Order: Introduction – Formation of differential equation, solutions of first order and first degree differential equations: variable separable form, homogeneous, exact, linear differential equations.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the knowledge of calculus to solve problems related to polar curves and its applications.
CO2	Apply the concept of integration and variables to evaluate multiple integrals and their usage in computing the area and volumes.
CO3	Illustrate the applications of multivariate calculus to understand the solenoidal and

	irrotational vectors and also exhibit the inter dependence of line, surface and volume integrals.
CO4	Understand the basic Concepts of Probability.
CO5	Recognize and solve first-order ordinary differential equations occurring in different branches of engineering.

Reference Books	
1.	Higher Engineering Mathematics,B.S. Grewal, 2013**,** 43rd Edition, Khanna Publishers.
2.	Calculus and Linear Algebra, G. B. Gururajachar, 2018-19, Academic Excellent Series Publication.
3.	Engineering Mathematics-I, Chandrashekar K. S, 2010, Sudha Publications.

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	**3**	**3**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**1**
CO2	**3**	**3**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**1**
CO3	**3**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**1**
CO4	**2**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**1**
CO5	**2**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**

High-3, Medium-2, Low-1

Semester: IV		
COMPLEX ANALYSIS, PROBABILITYAND SAMPLING THEORY (Theory)		
Course Code:	**MVJ21MA41C**	**CIE Marks:50**
Credits: L:T:P:	**2:2:0**	**SEE Marks: 50**
Hours:	**50L**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the concepts of Complex variables and transformation for solving EngineeringProblems.	
2	Understand the concepts of complex integration, Poles, and Residuals in the stability analysis ofengineering problems.	
3	Use statistical methods in curve fitting applications.	
4	To understand the probability distribution in civil and chemical engineering.	
5	Understand the concepts of Sampling theory in science and engineering.	

UNIT-I	
Complex variables - I: Functions of complex variables (Review), Analytic function, Cauchy-Riemann Equations in Cartesian and polar coordinates, Construction of analytic functions (Using Milne-Thomson method). **Transformations:** Bilinear Transformation, Conformal transformation, Discussion of the transformation $w = z^2, w = e^z and\ w = z + \frac{1}{z}(z \neq 0)$	**10 Hrs**
UNIT-II	
Complex variables-II: Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series- Problems, Singularities, Types of Singularities, Poles, Residues-definitions, Cauchy residue theorem (without proof) - Problems.	**10 Hrs**
UNIT-III	
Statistical Methods: Introduction, Correlation and coefficient of correlation, Regression - line of regression problems. Curve Fitting: Curve fitting by method of least squares- fitting of the curves of the form, $y = ax + b, y = ax^2 + bx + c\ and\ y = ae^{bx}$.	**10 Hrs**
UNIT-IV	
Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution, Geometric distribution and normal distributions - problems. Joint probability distribution: Joint Probability distribution for two discrete random variables,expectation, covariance.	**10 Hrs**
UNIT-V	
Sampling Theory and Statistical Inference: Sampling, Type I and Type II errors, standard error, confidence limits, test of hypothesis for means, test for hypothesis for proportions, student's t- distribution, Chi-square distribution as a test of goodness of fit.	**10 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	State and prove Cauchy - Riemann equation with its consequences and demonstrate Con-formal Transformation.
CO2	Illustrate Complex Integration using Cauchy's Integral theorem, Cauchy's Integral formulaand Cauchy's Residue theorem.
CO3	Use Method of Least Square for appropriate Curves. And Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.
CO4	Develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, information theory and design engineering
CO5	Demonstrate testing of hypothesis of sampling distributions and illustrate examples related to discrete parameters.

Reference Books	
1.	Engineering Mathematics-III, Prof G.B.Gururajachar, 2016-17, Academic Excellent series Publications.
2.	Higher Engineering Mathematics, B.S. Grewal, 2013, 44th Edition, Khanna Publishers.
3.	Advanced Engineering Mathematics, Erwin Kreyszig, 2014, 10th edition, Wiley-India publishers.
4.	Higher Engineering Mathematics, Ramana B. V., 2006, Tata McGraw-Hill.

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	**3**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**--**
CO2	**3**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO3	**2**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**	**--**
CO4	**3**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**

High-3, Medium-2, Low-1

Semester: IV		
CHEMICAL ENGINEERING THERMODYNAMICS (Theory)		
Course Code:	**MVJ21CH42**	**CIE Marks: 50**
Credits: L:T:P:	**2:2:0**	**SEE Marks: 50**
Hours:	**40L**	**SEE Duration: 3 Hrs.**
Course Learning Objectives: The students will be able to		
1	Learn fundamentals of thermodynamics such as types of properties, processes, and laws of thermodynamics for flow and non-flow process.	
2	Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility, and problem-solving skills.	
3	Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.	
4	Study the estimation of partial molar properties, property changes of mixing, and ideal and non-ideal solutions.	
5	Learn the fundamentals of phase equilibrium, concept of chemical potential and chemical reaction equilibrium to find feasibility and extent of conversion for the industrial reactions.	

UNIT-I	
Basic concepts: system, surrounding and processes, closed and open systems, state and properties, intensive and extensive Properties, state and path functions, equilibrium state and phase rule, zeroth law of thermodynamics, heat reservoir and heat engines, reversible and irreversible processes. **First law of thermodynamics**: General statement of first law of thermodynamics, first law for cyclic process and non-flow processes, heat capacity. **Heat effects accompanying chemical reactions**: Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction.	**8 Hrs**
UNIT-II	
P-V-T Behaviour: P-V-T behaviour of pure fluids, equations of state and ideal gas law; processes involving ideal gas law: constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases: Vander Waals equation, Redlich – Kwong equation, Peng – Robinson equation, Virial equation, Compressibility charts: principles of corresponding states, generalized compressibility charts. **Second law of thermodynamics**: General statements of the second law, concept of entropy, the Carnot principle, calculation of entropy changes, Clausius inequality, entropy, and irreversibility, Third law of thermodynamics.	**8 Hrs**
UNIT-III	
Thermodynamic Properties of Pure Fluids: Reference properties, energy properties, derived properties, work function, Gibbs free energy, relationships among thermodynamic properties, exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, entropy heat	**8 Hrs**

capacity relations, modified equations for U & H, effect of temperature on U, H & S, Relationships between C_P & C_V, Gibbs- Helmholtz equation, fugacity, fugacity coefficient, effect of temperature and pressure on fugacity, determination of fugacity of pure gases, fugacity of solids and liquids, activity, effect of temperature and pressure on activity.	
UNIT-IV	
Properties of solutions: Partial molar properties, chemical potential, fugacity in solutions, Henry's law and dilute solutions, activity in solutions, activity coefficients, property changes of mixing, excess properties.	**8 Hrs**
UNIT-V	
Phase Equilibria: Criteria of phase equilibria, Criterion of stability, Duhem's theorem, Vapor – Liquid Equilibria, VLE in ideal solutions, non-Ideal solutions, VLE at low pressures, VLE at high pressures, consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem's equation.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Calculate the heat and work requirements for the given flow or non-flow processes.
CO2	Analyse and find properties such as pressure, volume, and temperature for equations of states and from the fundamentals of first law of thermodynamics.
CO3	Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
CO4	Differentiate between ideal and non-ideal solution and estimate partial molar properties.
CO5	Identify the role of thermodynamics in the design and operation of chemical reaction system.

Reference Books	
1	Smith, J. M., Van Ness, H. C., & Abbott, M. M. (1987). Introduction to Chemical Engineering Thermodynamics, McGraw Hill. Inc.: New York.
2	Rao, Y. V. C. (1997). Chemical Engineering Thermodynamics. Universities Press.
3	Narayanan, K. V. (2004). A Textbook of Chemical Engineering Thermodynamics. PHI Learning Pvt. Ltd.

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**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**2**	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**2**	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**2**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**2**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
CHEMICAL PROCESS INDUSTRIES (Theory)		
Course Code:	**MVJ21CH43**	**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 basic concepts of Industrial Processes practiced in different Inorganic & Organic Chemical Industries.	
2	Get insight into the safety and environmental management schemes practiced.	
3	Assess different engineering problems of individual processes.	
4	Understand the plant layout and equipment used in the processes.	

UNIT-I	
Symbolic Representation of different unit operations and processes to build a flow sheet. Industrial gases and acids: Industrial Gases: CO_2, H_2, O_2, N_2, SO_2, SO_3. Industrial Acids: Sulphuric, Nitric, Hydrochloric and Phosphoric Acids. Water: Introduction, impurities in water, soft water-hard water, causes of hardness, disadvantages of hard water, measurement of hardness, methods of softening of water, purification of water, treatment of boiler feed water. Soaps and detergents: Soaps and detergents, theory of detergency.	**8 Hrs**
UNIT-II	
Cement industries: Classification, manufacture, reactions, flow diagrams, major and minor engineering problems, applications. **Fermentation industries:** Production of alcohol, Manufacture of beer, wines and liquors. **Oils, fats, waxes:** Vegetable and animal oils and fats. Extraction of vegetable oils, refining of edible oils. Hydrogenation of oils, waxes and their applications.	**8 Hrs**
UNIT-III	
Chlor-alkali and cement industries: sodium chloride, soda ash, caustic soda, chlorine. Cement industries: classification, manufacture, reactions, flow diagrams, major and minor engineering problems, applications.	**8 Hrs**
UNIT-IV	
Petroleum industries and petrochemicals: Origin and classification. Petroleum refining and processing Coal: Formation and Classification of coal, mining of coal, destructive distillation of coal, coking of coal, coal tar distillation, chemicals from coal. **Pulp and Paper Industries:** Raw materials, manufacture of pulp, paper and its major engineering problems.	**8 Hrs**
UNIT-V	
Inorganic fertilizers: Ammonia, urea, ammonium phosphate, ammonium nitrate, ammonium sulphate, DAP, phosphorous pentoxide, super phosphate and triple super phosphate. **Polymers & Rubber:** Macromolecules. Polymerization. PVC, LDPE. Polypropylene. Natural rubber.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basic processes for manufacture of industrial gases, acids, soaps and Detergents also sources, impurities and treatment methods of water.
CO2	Get insight of cement manufacture, fermentation products and basic concepts of industrial processes practiced in the manufacture of Oils, Fats, and Waxes.
CO3	Outline the manufacture of Chlor-alkali and Cement industries.
CO4	Explain the refining of petroleum, formation, classification of coal, destructive distillation of coal and manufacture of pulp and paper.
CO5	Learn industrial scale operations and processes employed in manufacture of fertilizers & polymers and rubber.

Reference Books	
1	Outlines of chemical technology, Dryden, C. E., Rao, M. G., & Sittig, M., 1973, Affiliated East-West P..
2	Chemical Process Industries, Shreve, R. N., & Brink Jr, J. A., 1977, 4th Edition, McGraw-Hill Book Co..
3	Encyclopedia of chemical technology, Kroschwitz, J. I., Howe-Grant, M., Kirk, R. E., & Othmer, D. F., 1996, 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

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

CO3	**2**	**1**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**2**	**1**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**2**	**1**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
PROCESS HEAT TRANSFER (Theory and Practice)		
Course Code:	**MVJ21CH44**	**CIE Marks:50+50**
Credits: L:T:P:	**2:2:2**	**SEE Marks: 50 +50**
Hours:	**40 L+ 26 P**	**SEE Duration: 03+03 Hrs**
Course Learning Objectives: The students will be able to		
1	Study various modes of Heat transfer and their fundamental relations.	
2	Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.	
3	Study the Boiling phenomenon and to generate pool boiling curve.	
4	Understand the working and basic design of Heat exchangers.	
5	Understand the phenomenon of radiation, radiation shields and estimation of emissivity.	

UNIT-I	
Introduction: the importance of heat transfer in chemical engineering operations, modes of heat transfer. **Conduction**: Fourier's law, steady state unidirectional heat flow through single and multiphase layers slabs, cylinders, and spheres for constant and variable thermal conductivity. thermal conductivity measurement; effect of temperature on thermal conductivity, properties of insulation materials, types of insulation, the critical and optimum thickness of insulation.	**8 Hrs**
UNIT-II	
Extended Surfaces: types of fins, fin efficiency for longitudinal fins, fin effectiveness. **Convection**: individual and overall heat transfer coefficient, LMTD, LMTD correction factor, dimensionless numbers, dimensional analysis, empirical correlation for forced and natural convection, analogy between momentum and heat transfer; Reynold, Colbourn, prandtl analogies.	**8 Hrs**
UNIT-III	
Heat Transfer with Phase Change: heat transfer to fluids with phase change; heat transfer from condensing vapours, drop wise and film wise condensation, nusselt equation for vertical and horizontal tubes, condensation of superheated vapors, effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.	**8 Hrs**
UNIT-IV	
Radiation: properties and definitions, emissive power and intensity of radiation, black body radiation, grey body radiation, Stefan – Boltzmann law, Wein's displacement law, Kirchhoff's law, radiation shape factor, radiation between large parallel plates.	**8 Hrs**
UNIT-V	
Heat Transfer Equipment: double pipe heat exchanger. shell and tube heat exchangers, condensers, construction and working, types of shell and tube heat	**8 Hrs**

exchangers, type of condensers. **Design of Heat Transfer Equipment:** elementary design of double pipe heat exchanger. shell and tube heat exchanger and condensers. **Evaporation:** single and multiple effect operation, material and energy balance in evaporators, forward and backward feeds, capacity and economy of evaporators, multiple effect evaporator; methods of feeding.	

LABORATORY EXPERIMENTS

1	Bare tube heat exchanger
2	vertical shell and tube heat exchanger (Condenser)
3	Horizontal Shell and tube Heat exchanger (Condenser)
4	Helical Coil Heat exchanger
5	An emissivity of grey surface
6	Heat transfer coefficients in a packed bed
7	Double pipe Heat exchanger
8	Heat transfer in a jacketed vessel
9	Transient heat conduction
10	Heat Transfer in Fluidized Beds
11	Single effect evaporator
12	Spiral plate heat exchanger
13	Cross flow heat exchanger
14	Finned tube heat exchanger
15	Stefan Boltzmann constant for radiation heat transfer
16	Experiment to verify Fourier's law

Any 12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop flux equations for steady state heat conduction and critical thickness of insulation in different geometry of solids.
CO2	Explain the types of fins, fin effectiveness and apply various correlations of convective heat transfer to different problems.
CO3	Derive the Nusselt equation for heat transfer with phase change.
CO4	Interpret the phenomenon of radiation in different types of solids.
CO5	Develop the elementary design equations for various Heat exchangers.

Reference Books	
1.	Unit operations of Chemical Engineering, McCabe, W. L., Smith, J. C., & Harriott, P., 1993, McGraw-Hill.
2.	Heat Transfer, Rao, Y.V.C, 2002, Universities Press.
3.	Fluid Flow, Heat Transfer and Mass Transfer, Coulson J.M, Richardson J.F, Backhurst JR and Harker J.H., 2002, 5th ed., Elsevier.
4.	Heat transfer: principles and applications, Dutta, B. K., 2000, PHI Learning.

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 self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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 complete 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	**3**	**3**	**2**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
CHEMICAL REACTION ENGINEERING (Theory and Practice)		
Course Code: MVJ21CH 45		**CIE Marks:50+50**
Credits: L:T:P 2:2:2		**SEE Marks: 50 +50**
Hours:40 L+ 26 P		**SEE Duration: 03+03 Hours**
Course Learning Objectives: The students will be able to		
1	Understand the scope of Chemical Reaction Engineering.	
2	Analyze and interpret the experimental data to determine kinetic rate equation and understand the design of ideal reactor systems.	
3	Understand the concept of non-isothermal reactors.	
4	Understand and apply the principles of non-ideal flow in the design of reactor.	

UNIT-I	
Introduction to Chemical Reactions. Homogeneous and heterogeneous reactions with their basic definitions, Elementary and non-elementary reactions, reaction rate and rate constant, order and molecularity of a reaction, Temperature dependency of rate constant and kinetic modelling: Arrhenius, collision and transition state theories. **Types of Reactors:** Batch, Semi-batch, laminar, and mixed flow reactors. Multiphase reactors of Industrial Importance (fixed, fluidized and bubble column reactors) and their practical demonstration.	**8 Hrs**
UNIT-II	
Design of Reactors: Design of Batch, Semi-batch, and mixed flow ideal reactors and their performance equations. Constant volume and variable volume reactors. Space time and space velocity, Holding time for flow reactors. Size comparison of ideal reactors.	**8 Hrs**
UNIT-III	
Multiple Reactor Systems: Plug flow and /or Mixed flow reactors in Series, parallel and series-parallel. Reactors of different types and sizes in series. Design of Reactors for Multiple Reactions: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series- Parallel reactions (Only irreversible reactions must be considered).	**8 Hrs**
UNIT-IV	
Non-Isothermal Reactors: Introduction, effect of temperature on equilibrium constant and heat of reaction, Material and Energy balances, conversions in adiabatic and non-adiabatic reactors. **Basics of Non-Ideal Flow:** importance & interpretation of RTD, C, E & F curves & statistical interpretation. Dispersion model. Tanks in series model. Conversion in non-ideal flow reactors for simple systems.	**8 Hrs**
UNIT-V	
Catalysis: introduction to catalysis. Properties of catalysts. Estimation methods	**8 Hrs**

for catalytic properties. promoters, inhibitors etc, mechanism of catalysis. rate equations for different rate controlling step. **Deactivation:** deactivating catalyst.	

LABORATORY EXPERIMENTS
1. Interpreting isothermal batch reactor experimental data using the Integral method of analysis. 2. Performing saponification reaction in an isothermal plug flow reactor 3. Performance of an isothermal mixed flow reactor 4. Study the performance of a semi-batch reactor for a saponification reaction 5. Degradation kinetics of dye in a photochemical reactor. 6. Performing esterification reaction in an adiabatic batch reactor. 7. Performing saponification reaction in a packed bed reactor. 8. RTD studies in Tubular reactor 9. Effect of temperature on Rate of reaction 10. RTD Studies in mixed flow reactor. 11. Degradation kinetics of dye in a sonochemical reactor. 12. Estimating Physico-chemical properties of a catalyst.
12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain various types of reactions, factors affecting rate equation, theories for predicting temperature dependency of rate constant and kinetics.
CO2	Interpret experimental data using differential, integral, and half-life methods, and types of chemical reactors with real practice. and Develop design equations for ideal reactors.
CO3	Develop the design of single and multiple reactor systems and non-isothermal reactors and discuss optimum temperature progression.
CO4	Interpret non ideality in a reactor using RTD data and predict conversion using various models like Dispersion and tanks in series model.
CO5	Derive the rate expressions for heterogeneous catalytic reactions and Catalytic deactivation

Reference Books	
1.	Chemical reaction engineering, Levenspiel, O., 1998, 3rd ed. John wiley & sons.
2.	Elements of Chemical Reaction Engineering, Fogler, H.S., 2010, 4th ed, Pearson New International Edition.
3.	Chemical engineering kinetics, Smith, J. M., 1981, 3rd ed. McGraw-Hill.
4.	Chemical and catalytic reaction engineering, Carberry, J. J., 2001, Dover.

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 self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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 complete 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.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

High-3, Medium-2, Low-1

Semester: IV		
CONSTITUTION OF INDIA AND PROFESSIONAL ETHICS AND CYBER LAW (Theory)		
Course Code: MVJ21CPH46		**CIE Marks:50**
Credits: L:T:P: 1:0:0		**SEE Marks: 50**
Hours: 15L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.	
2	To provide overall legal literacy to the young technograts to manage complex societal issues in the present scenario.	
3	To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.	

UNIT-I	
Introduction to Indian Constitution: The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.	**3 Hrs**
UNIT-II	
Union Executive and State Executive: Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.	**3 Hrs**
UNIT-III	
Elections, Amendments and Emergency Provisions: Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements). Emergency Provisions, types of Emergencies and it's consequences. **Constitutional Special Provisions:** Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.	**3 Hrs**

UNIT-IV	
Professional / Engineering Ethics: Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	**3 Hrs**
UNIT-V	
Internet Laws, Cyber Crimes and Cyber Laws: Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.	**3 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Have constitutional knowledge and legal literacy
CO2	Understand Engineering and Professional ethics and responsibilities of Engineers.
CO3	Understand the cyber crimes and cyber laws for cyber safety measure.

Reference Books	
1.	Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher
2.	Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th/20th Edn., (Latest Edition) or 2008.
3.	Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.

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	--	--	--	--	--	--	--	--	--	--	--	--
CO2	**2**	--	--	--	--	--	--	**3**	--	--	--	--
CO3	--	--	--	--	--	--	--	--	--	--	--	--

High-3, Medium-2, Low-1

Semester: IV		
AEC4: SOFTWARE TOOLS FOR CHEMICAL ENGINEERS (Theory and Practice)		
Course Code: MVJ21CH47		**CIE Marks:50+50**
Credits: L:T:P: 1:0:2		**SEE Marks: 50 +50**
Hours:10 L+ 20 P		**SEE Duration: 03+03 Hours**
Course Learning Objectives: The students will be able to		
1	Understand the basic concepts of different software used for the various chemical processes.	
2	Get insight into the design software practiced.	
3	Assess different engineering problems using the relevant software.	
4	Understand the plant layout and equipment used in the processes.	

UNIT-I	
General introduction to process engineering design software (HYSYS and PRO II); computations using Microsoft excel; computer-aided design & drafting, piping and equipment design software.	**2 Hrs**
UNIT-II	
Process Simulation software- Introduction to Aspen HYSYS, Aspen PLUS, and CHEMCAD.	**2 Hrs**
UNIT-III	
General Mathematical Modelling: introduction to MATLAB Simulink.	**2 Hrs**
UNIT-IV	
Computational Fluid Dynamics: introduction to COMSOL Multiphysics, ANSYS Fluent.	**2 Hrs**
UNIT-V	
Statistical software: introduction to Design of Experiments (DOE), Six Sigma Tools, Artificial Neural Networks (ANN).	**2 Hrs**

LABORATORY EXPERIMENTS

1. Data export from MS Excel to MAT LAB.
2. A typical shortcut approach for the initial conceptual estimation of the operation of binary distillation columns.
3. Modeling of Heat Exchanger using MAT LAB.
4. Determination of size of Heat Exchanger using CC-THERM (CHEMCAD).
5. Simulation of Steady state conditions problems using DWSIM software.
6. Simulation of Steady state –Vapor-Liquid conditions problems using DWSIM software.
7. Simulation of Steady state –Vapor-Liquid-Liquid conditions problems using DWSIM software.
8. Simulation of Steady state Solid-Liquid-Liquid conditions problems using DWSIM software.
9. Simulation of Steady state aqueous Electrolyte numerical problems using DWSIM software.
10. Performance of Internal combustion Engines using CFD software.

11. Determination of Pressure drops of a pump using ASPEN HYSYS. 12. Determination of Mass Balance Using ASPEN HYSYS.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basic processes of engineering design software.
CO2	Get an insight of mathematical modeling practiced using MATLAB software.
CO3	Outline the process simulation software.
CO4	Explain the computational fluid dynamics with various software.
CO5	Learn the statistical software for the design of experiments.

Reference Books	
1.	Introduction to Software for Chemical Engineers, Mariano Martin, 2019, 2nd edition, CRC Press.
2.	Chemical Process Engineering Volume 2: Design, Analysis, Simulation, Integration, and Problem Solving with Microsoft Excel-UniSim Software for Chemical Engineers, Heat Transfer and Integration, Process Safety, and Chemical Kinetics, Kayode A.C., Rahmat S-G, 2022, John Wiley and Sons.
3.	ASPEN PLUS® Chemical Engineering Applications, Al-Malah, K.I.M, 2016, Wiley.
4.	Fortan Programs for Chemical Process Design, Analysis, and Simulation, Kayode Coker 1995, Gulf Professional Publishing.

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.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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	**3**	**1**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO2	**3**	**1**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO3	**3**	**1**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**1**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**1**	**2**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
ADDITIONAL MATHEMATICS-II **(Common to all branches)**		
Course Code: MVJ21MATDIP-II		**CIE Marks:50**
Credits: L:T:P: 1:2:0		**SEE Marks: 50**
Hours: 40L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	To familiarize the important concepts of linear algebra.
2	Aims to provide essential concepts differential calculus, beta and gamma functions.
3	Introductory concepts of three-dimensional geometry along with methods to solve them.
4	Linear differential equations.
5	Formation of partial differential equations.

UNIT-I	
Linear Algebra: Introduction - Rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Diagonalization of a square matrix of order two. **Self study**: Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix-Examples.	**8 Hrs**
UNIT-II	
Differential calculus: Indeterminate forms: L-Hospital rule (without proof), Total derivatives, and Composite functions. Maxima and minima for a function of two variables. **Beta and Gamma functions:** Beta and Gamma functions, Relation between Beta and Gamma function-simple problems. **Self study**: Curve tracing.	**8 Hrs**
UNIT-III	
Analytical solid geometry : Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems. **Self study**: Volume tetrahedron.	**8 Hrs**
UNIT-IV	
Differential Equations of higher order: Linear differential equations of second and higher order equations with constant coefficients. Inverse Differential operator, Operators methods for finding particular integrals , and Euler –Cauchy equation. **Self study**: Method of variation of parameters	**8 Hrs**
UNIT-V	
Partial differential equation: Introduction- Classification of partial differential equations, formation of partial differential equations. Method of elimination of	**8 Hrs**

arbitrary constants and functions. Solutions of non-homogeneous partial differential equations by direct integration. Solution of Lagrange's linear PDE. **Self study:** One dimensional heat and wave equations and solutions by the method of separable of variable	

Course Outcomes: After completing the course, the students will be able to	
CO1	Make use of matrix theory for solving system of linear equations and compute eigenvalues and eigen vectors required for matrix diagonalization process.
CO2	Learn the notion of partial differentiation to calculate rates of change of multivariate functions and solve problems related to composite functions and Jacobians.
CO3	Understand the Three-Dimensional geometry basic, Equation of line in space- different forms, Angle between two line and studying the shortest distance .
CO4	Demonstrate various physical models through higher order differential equations and solve such linear ordinary differential equations.
CO5	Construct a variety of partial differential equations and solution by exact methods.

Reference Books	
1.	B.S. Grewal, Higher Engineering Mathematics**,** Khanna Publishers, 43rd Edition**,** 2013**,** .
2.	G. B. Gururajachar, Calculus and Linear Algebra, Academic Excellent Series Publication 2018-19
3.	Chandrashekar K. S, Engineering Mathematics-I, Sudha Publications, 2010.

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	3	3	--	2	--	--	--	--	--	--	1	1
CO2	3	3	--	2	--	--	--	--	--	--	1	1
CO3	3	3	--	3	--	--	--	--	--	--	--	1
CO4	2	2	--	3	--	--	--	--	--	--	1	1
CO5	2	2	--	2	--	--	--	--	--	--	--	1

Semester: V		
TECHNICAL MANAGEMENT & ENTREPRENEURSHIP (Theory)		
Course Code: MVJ21CH51		**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	Introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
2	Explain need of coordination between the manager and staff, the social responsibility of business and leadership.
3	Explain the role and importance of the entrepreneur in economic development and the concepts of entrepreneurship.
4	Discuss the importance of Small-Scale Industries and the related terms and problems involved.
5	Explain project feasibility study and project appraisal and discuss project financing.

UNIT-I	
Management: Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession. Planning: Nature, Importance and Purpose of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.	**8 Hrs**
UNIT-II	
Organizing and Staffing: Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Vs Decentralization of Authority and Responsibility, Span of Control, Nature and Importance of Staffing, Process of Selection and Recruitment. **Directing and Controlling:** Meaning and Nature of Directing-Leadership Styles, Motivation Theories, Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling.	**8 Hrs**
UNIT-III	
Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. **Entrepreneurship:** Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.	**8 Hrs**
UNIT-IV	

Modern Small Business Enterprises: Role of Small Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only). **Institutional Support for Business Enterprises:** Introduction, Policies & Schemes of Central– Level Institutions, State-Level Institutions.	**8 Hrs**
UNIT-V	
Project Management: Meaning of Project, Project Objectives & Characteristics, Project Identification- Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation. New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the concept of Management.
CO2	Understand the staffing process.
CO3	Explain the social responsibilities of business towards different groups.
CO4	Explain the role of small scale industries.
CO5	Interpret the project objective.

Reference Books	
1.	Management‖, Stephen P. Robbins & Mary Coulter,2009, Prentice Hall (India) Pvt. Ltd., 10th Edition,
2.	Management‖, JAF Stoner, Freeman R.E and Daniel R Gilbert,2004,Pearson Education, 6 th Edition.
3.	Essentials of management, Harold Koontz & Heinz Weihrich ,1998, Tata McGraw Hill.
4.	Principles of Management,Tripathy PC & Reddy PN,1999, , Tata McGraw Hill.

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**	**3**	**2**	**--**	**--**	**--**	**1**	**1**	**--**	**1**	**1**
CO2	**2**	**2**	**1**	**2**	**2**	**--**	**1**	**1**	**1**	**1**	**1**	**1**
CO3	**2**	**2**	**1**	**2**	**2**	**--**	**--**	**--**	**--**	**--**	**1**	**1**
CO4	**2**	**2**	**1**	**1**	**--**	**2**	**--**	**1**	**1**	**--**	**1**	**1**
CO5	**3**	**3**	**1**	**2**	**2**	**--**	**--**	**1**	**1**	**--**	**1**	**1**

High-3, Medium-2, Low-1

Semester: V		
MASS TRANSFER – I (Theory)		
Course Code:MVJ21CH52		**CIE Marks: 50**
Credits: L:T:P: 2:2:0		**SEE Marks: 50**
Hours: 40L		**SEE Duration: 3 Hrs.**

Course Learning Objectives: The students will be able to	
1	Formulate equations for estimation of diffusivities in fluids & solids using first principles of engineering sciences.
2	Apply mass transfer fundamentals to calculate mass transfer rates and design the mass transfer equipment

UNIT-I	
Types of diffusion in fluids and solids. Measurement and calculations of diffusivities. Multi component diffusion. Mass transfer coefficients and their correlations. Theories of mass transfer. Inter phase mass transfer. material balance for co-current, cross-current and counter-current operations. concept of stages, cascades operation, NTU and HTU concepts	**8 Hrs**
UNIT-II	
Humidification: General theory, Psychometric chart. Adiabatic saturation temperature, Wet bulb temperature, Concepts in humidification dehumidification. Design of cooling towers.	**8 Hrs**
UNIT-III	
Drying: Introduction, Equilibria, drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers.	**8 Hrs**
UNIT-IV	
Adsorption: Theories of adsorption. Isotherms, industrial adsorbents. equipment, batch & continuous multistage adsorption	**8 Hrs**
UNIT-V	
Crystallization: Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles into design of equipment. Different types of crystallizer equipment. **Introduction to Separation Techniques:** Ion exchange, Membrane Processes-Reverse Osmosis, Dialysis, Ultra and Micro-filtrations, Super-critical fluid extraction. (Working principle and operations only)	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles of diffusion in solids and fluids and interpret the behavior the mass transfer coefficients using various theories and HTU and NTU concepts.
CO2	Explain concepts, application of humidification, dehumidification and design of cooling towers.
CO3	Comprehend operation, concepts and types of dryers.
CO4	Explain various isotherms, modes of adsorption operations, types of adsorber and design of packed bed adsorber.
CO5	Apply principles of crystallization in design of crystallizer and illustrate the working

	principle of various novel separation techniques.

Reference Books	
1.	Mass transfer operations. Treybal, R. E., 1980 New York, 466.
2.	Unit Operations in Chemical Engineering, McCabe & Smith, 2001, 6th edn, McGraw Hill.
3.	Transport processes and separation principles (include unit operation), Geankoplis, C. J. 2003.
4.	Chemical Engineering Vol I, II, III, IV and V, Coulson and Richardson, 1988, 4th edn, Pergamon Press.

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	**3**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**

High-3, Medium-2, Low-1

Semester: V		
INSTRUMENTAL METHODS OF ANALYSIS (Theory and Practice)		
Course Code:MVJ21CH53		**CIE Marks:50+50**
Credits: L:T:P: 3:0:2		**SEE Marks: 50 +50**
Hours:40 L+26P		**SEE Duration: 03+03 Hours**

Course Learning Objectives: The students will be able to	
1	The course is designed to impart the knowledge in the field of Instrumental Analysis. The various modern analytical techniques like UV-Visible, IR, NMR, Mass, GC, HPLC, different chromatographic methods and other important topics are taught to enable the students.
2	To understand and apply the principles involved in the determination of different bulk drugs and their formulation. In addition to the theoretical aspects, the basic practical knowledge relevant to the analysis is also imparted.

UNIT-I	
Chromatography: Introduction, classification of chromatographic methods based on the mechanism of separation. Column Chromatography: Adsorption and partition, theory, preparation, procedure and methods of detection. **Thin Layer Chromatography:** Theory, preparation, procedures, detection of compounds. **Paper Chromatography:** Theory, different techniques employed, filter papers used, qualitative and quantitative detection. Counter – current extraction, solid phase extraction techniques, gel filtration.	**8 Hrs**
UNIT-II	
Gas chromatography: introduction, fundamentals, instrumentation, columns: preparation and operation, detection, dramatization. **Liquid chromatography**: HPLC- Principles and instrumentation, solvents and columns, detection and applications.	**8 Hrs**
UNIT-III	
Spectroscopy: Introduction, electromagnetic spectrum. **UV-Visible spectroscopy:** absorbance laws and limitations, instrumentation-design and working principle, chromophore and auxochromes concept, Wood-Fisher rules for calculating absorption maximum, applications of UV-Visible spectroscopy. **IR spectroscopy:** Basic principles-Molecular vibrations, vibrational frequency, factors influencing vibrational frequencies, sampling techniques, instrumentation, interpretation of spectra, FT-IR, theory and applications.	**8 Hrs**
UNIT-IV	
Mass spectroscopy: Theory, ionization techniques: electron impact ionization, chemical ionization, field ionization, fast atom bombardment, plasma desorption, fragmentation process: types of fission, resolution, GC/MS, interpretation of spectra and applications for identification and structure determination. **X-ray diffraction (XRD):** Bragg's law, basic powder diffraction, generation of X-rays, Instrumentation, Scherer equation, BCC and FCC Bravis lattice, phase identification using XRD.	**8 Hrs**
UNIT-V	
NMR: theory, instrumentation, chemical shift, shielding and de-shielding effects,	

splitting of signals, spin-spin coupling, proton exchange reactions, coupling constant (J), Nuclear OverHauser effect (NOE), ^{1}HNMR, ^{13}C-NMR spectra and its applications	**8 Hrs**

LABORATORY EXPERIMENTS

1. Analysis of effluents for pH and alkalinity
2. Determination of BOD
3. Volatile, Fixed, Filterable and Dissolved solid analysis
4. Analysis by ion selective electrode (any two anions)
5. Measurement of particulate matter in Air
6. Measurement of SO2 in air
7. Analysis of exhaust by ORSAT apparatus
8. Determination of COD
9. UV Spectrophotometer
10. UV Spectrophotometer
11. Flame photometer
12. Dissolved Oxygen measurement
13. Bomb calorimeter
14. Viscometer
15. Potentiometer titration
16. Jar test apparatus

Any 12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze various parameters to assess pollution in water and air.
CO2	Interpret qualitative composition of a solution using instruments like Bomb calorimeter, Viscometer.
CO3	Interpret quantitative composition of a solution using instruments like turbid meter, KF Auto titrator.
CO4	Analysis of Volatile, Fixed, Filterable and Dissolved solids.
CO5	Measurement of particulate matter and SO2 in air.

Reference Books	
1.	Air pollution engineering manual, Davis, W. T., & Buonicore, A. J., (2000). New York: McGraw-Hill.
2.	Standard methods for the examination of water and wastewater, Baird, R. B. (2017).
3.	Practical waste treatment and disposal. Edited by Denis Dickinson. Compiled in collaboration with the Institute for Industrial Research and Standards, Dickinson, D. (1974)
4.	Pollution control in process industries., Mahajan, S. P. (1985).Tata McGraw-Hill Education

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.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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	**3**	**--**	**--**	**--**	**--**	**3**	**3**	**3**	**--**	**--**	**--**	**--**
CO2	**3**	**--**	**--**	**--**	**--**	**3**	**3**	**3**	**--**	**--**	**--**	**--**
CO3	**3**	**--**	**--**	**2**	**--**	**3**	**3**	**3**	**--**	**--**	**--**	**--**
CO4	**3**	**--**	**--**	**2**	**--**	**3**	**3**	**3**	**--**	**--**	**--**	**--**
CO5	**3**	**--**	**--**	**--**	**--**	**3**	**3**	**3**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: V		
PROCESS CONTROL & IIOT (Theory and Practice)		
Course Code: MVJ21CH54		**CIE Marks:50+50**
Credits: L:T:P:2:2:2		**SEE Marks: 50 +50**
Hours:40 L+26P		**SEE Duration: 03+03 Hours**
Course Learning Objectives: The students will be able to		
1	To determine possible control objectives, input variables (manipulated variables and disturbances) and, to model the dynamic behavior of a process.	
2	To deal with control equipment and various controllers and their functions and applications.	
3	To understand the frequency response and analyze stability of closed loop and open loop systems.	
4	To study about the various industrial revolutions and role of IOT & IIOT in industry.	

UNIT-I	
Introduction to process control and modeling consideration: Introduction to chemical process control, process modeling and an example, linearization of a non-linear model, linearization and its application in process control, Laplace Transforms - Standard functions. **First Order Systems:** Development of transfer functions, open loop systems, thermometer, level, mixing tank, STR, I order systems in series. Response for various input forcing functions, first order systems and their transient response for standard input functions, first order systems in series.	**8 Hrs**
UNIT-II	
Second Order Systems: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case – Terms associated with it. Transportation lag. **Closed Loop System:** Development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic controllers	**8 Hrs**
UNIT-III	
Stability: Stability of linear control systems. Routh Test. **Frequency response:** Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, Principle of Nyquist diagram, stability criterion. **Control System Design By Frequency Response:** Bode criterion. Gain and Phase margins, Tuning of controller settings, Ziegler – Nichols controller tuning, Cohen-Coon controller tuning.	**8 Hrs**
UNIT-IV	
Advanced Control System: Introduction to advanced control systems, cascade control, feed forward control. Introduction to computer control of chemical processes: Digital Computer control loops	**8 Hrs**
UNIT-V	
Introduction to Industrial IoT (IIoT) Systems: The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0,	**8 Hrs**

Smart Factories.	

LABORATORY EXPERIMENTS

1. Determination of time constant of thermocouple
2. Step response of a single tank system
3. Step response of non-interacting Tanks
4. Step Response of interacting tanks
5. Transient behaviour of pressure vessel system
6. Dynamics of a 2nd order under damped process- U Tube Manometer
7. Impulse Response of a single tank system
8. Impulse Response of non-interacting Tanks
9. Impulse Response of Interacting Tanks
10. Level/Flow/Pressure/pH/Temperature control – P controller
11. Level/Flow/Pressure/pH/Temperature control – PI controller
12. Level/Flow/Pressure/pH/Temperature control – PD controller
13. Level/Flow/Pressure/pH/Temperature control – PID controller
14. Determination of valve characteristics
15. Characteristics of flapper nozzle system

Any 12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret the process control and modelling considerations and model the dynamics of a first order process.
CO2	Develop the transfer functions for a second system and derive the transient response of servo and regulator control with various control modes.
CO3	Analyze the stability for a given linear control systems using Routh Hurwitz criteria and the frequency response using Bode and Nyquist diagrams, Analyze the control system design by frequency response and plot root locus diagram for different process.
CO4	Discuss cascade control, feed forward control and the digital digital computer control loops.
CO5	Study about the role of Internet of Things (IOT) and Industrial Internet of Things (IIOT) in industry.

Reference Books	
1.	Process systems analysis and control, Coughanowr, D. R., & Koppel, L. B., (1965). New York: McGraw-Hill.
2.	Chemical process control (Vol. 2), Stephanopoulos, G. (1984), New Jersey: Prentice Hall.
3.	Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist Publications: A press
4.	Process modeling, simulation and control for chemical engineers, Benenati, R. F., (1973). William L. Luyben, McGraw-Hill, New York.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Laboratory- 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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	**3**	**3**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**2**	**2**	**2**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**2**	**2**	**2**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**2**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**2**	**2**	**2**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: V		
CHEMICAL PROCESS INSTRUMENTATION (Theory)		
Course Code: MVJ21CH551		**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 basic principles of various measuring instruments and its static, dynamic response.
2	Understand the various instruments utilized to measure the temperature and calculate the temperature using thermometer, thermistor, radiation, and pyrometer.
3	Understand to calculate the pressure using manometer and the fundamentals of pressure measuring devices.
4	Study the fundamentals of variable head meter, area flow meter, direct, inertial type level meter, and density measurement devices.
5	Understand to select suitable measuring device for gas mixture analysis, thermal, electrical conductivity, and viscosity and construct piping and instrumentation diagram.

UNIT-I	
Principles of measurement: analysis- measurement of force, strain and torque- use of strain gauges, transducers - resistive, capacitive, inductive and piezoelectric pickups, static and dynamic response of instruments. Errors in measurements.	**8 Hrs**
UNIT-II	
Temperature measurement: liquid filled, gas filled and vapour pressure thermometers. Bimetallic and resistance thermometers. Thermocouples and thermistors. Optical and radiation pyrometers.	**8 Hrs**
UNIT-III	
Pressure measurement: manometers, bourdon gauge, and bellow gauge. Measurement of pressure and vacuum. Use of transducers.	**8 Hrs**
UNIT-IV	
Flow, density and level measurements: variable head flow meters. Area flow meters, positive displacement meters, pressure probes, level measurements - direct and inertial types. Measurement of density and specific gravity. Instruments for weighing and feeding.	**8 Hrs**
UNIT-V	
Miscellaneous measurements: Analysis of gas mixtures, thermal conductivity, viscosity and electrical conductivity. Supporting instrumentation - standard cells, balancing circuits and terminating devices. Principles of telemetering. P and I diagrams.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basic principles of various measuring instruments and its static, dynamic response. Errors in the measurements.
CO2	Demonstrate the various instruments utilized to measure the temperature and calculate the temperature using thermometer, thermistor, radiation, pyrometer.
CO3	Calculate the pressure using manometer and demonstrate the basic fundamentals of

	pressure measuring devices.
CO4	Demonstrate the fundamentals of variable head meter, area flow meter, direct, inertial type level meter, and density measurement devices.
CO5	Select suitable measuring device for gas mixture analysis, thermal, electrical conductivity, viscosity and construct piping and instrumentation diagram.

Reference Books	
1.	Automatic process control, Eckman, D. P., 1967, Wiley.
2.	Mechanical and industrial Measurements, Jain, R. K., 1988, Khanna Publishers.
3.	Fundamentals of temperature, pressure, and flow measurements, Benedict, R. P., 1991, John Wiley & Sons.
4.	Perry's chemical engineers' handbook, Perry, R. H., & DW, G., 2007, 8th illustrated ed. New York: McGraw-Hill.

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												
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CO1	**2**	**2**	**1**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**2**	**3**
CO2	**2**	**2**	**1**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**2**	**3**
CO3	**2**	**2**	**1**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**2**	**3**
CO4	**2**	**2**	**1**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**2**	**3**
CO5	**2**	**2**	**1**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**2**	**3**

High-3, Medium-2, Low-1

Semester: V		
COMPUTATIONAL FLUID DYNAMICS (Theory)		
Course Code: MVJ21CH552		**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 introduce Governing Equations of viscous fluid flows.
2	To introduce numerical modeling and its role in the field of fluid flow and heat transfer.
3	To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
4	To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

UNIT-I	
Introduction: Illustration of the CFD approach, CFD as an engineering analysis tool, Review of governing equations, Modelling in engineering, Partial differential equations- Parabolic, Hyperbolic and Elliptic equation, CFD application in Chemical Engineering, CFD software packages and tools.	**8 Hrs**
UNIT-II	
Finite difference and finite volume methods: Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods	**8 Hrs**
UNIT-III	
Solution algorithms: Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.	**8 Hrs**
UNIT-IV	
Flow field analysis: Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.	**8 Hrs**
UNIT-V	
Turbulence models, mixing length model, Two equation (k-Ɛ) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the concept of computational fluid dynamics and its application
CO2	Analyze the consistency, stability and convergence of various discretization schemes for parabolic, elliptic and hyperbolic partial differential equations.

CO3	Apply finite difference and finite volume methods to various chemical engineering problems.
CO4	Analyze variations of SIMPLE schemes for incompressible flows and variations of Flux Splitting algorithms for compressible flows.
CO5	Evaluate the grid sensitivity and analyse the accuracy of a numerical solution.

Reference Books	
1.	An introduction to computational fluid dynamics: the finite volume method, Versteeg, H. K., & Malalasekera, W., 2007, Pearson education.
2.	Computational Fluid Flow and Heat Transfer, Muralidhar, K. and Sundararajan (Narosa), T., 2nd Edition, 2011.
3.	Numerical Heat Transfer and Fluid Flow, Patankar, S.V., 2004, Hemisphere Publishing Corporation.
4.	Computational fluid dynamics, Chung, T. J., 2002, Cambridge university press.

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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CO1	**3**	**3**	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: V		
PETROLEUM REFINING & PETROCHEMICALS (Theory)		
Course Code: MVJ21CH553		**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 history.	
2	Understand the extraction and production of oil and gas to meet energy needs.	

UNIT-I

Introduction: Origin and occurrence of petroleum crude, status of petroleum refining industry in india, classification and physical properties of petroleum testing, uses and blending of petroleum products. petroleum refining processes, atmospheric and vacuum distillation, thermal and catalytic cracking, vapor, liquid and mixing phases, hydro cracking.	**8 Hrs**
UNIT-II	
Catalyst reforming: Catalytic reforming, polymerization, isomerization, hydrogenation, production of aviation gasoline, motor fuel, kerosene, diesel oil and jet fuel.	**8 Hrs**
UNIT-III	
Treatment of Petroleum Products: Vacuum distillation, solvent extraction, uses of lubricating oils and petroleum waxes, chemical and clay treatment of petroleum products, desulfurization process for petroleum product, catalyst delayed coking, hydro treating & visbreaking.	**8 Hrs**
UNIT-IV	
Petroleum and Petrochemical Industries: Introduction to petrochemical industries in India, structure of petrochemical complexes, product profile of petrochemicals units. Olefin production (naptha & gas cracking), separation of aromatics (benzene, xylene and toluene), aromatic conversion processes (depropanization, isomerisation, dealkylation).	**8 Hrs**
UNIT-V	
Manufacture of major petrochemical, methanol and formaldehyde, ethylene oxide and ethylene glycol, acetaldehyde, butadiene, linear alkyl benzene.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Outline the overview of the modern, integrated petroleum refinery, its feedstocks, product state and the processes employed to convert crude oil and intermediate streams into finished products.
CO2	Classify the various treatment techniques employed in petroleum refining for the Production of wide spectrum of useful products.
CO3	Discuss the thermal and catalytic cracking methods employed in petroleum refining.
CO4	Identify suitable refining technology for maximizing the product yield.
CO5	Interpret the coking and the hydrocracking process employed and the environmental issues and new trends in petroleum refining.

Reference Books	
1.	Modern Petroleum Refining Processes, Rao, B., 2002, Oxford & IBH Publishing.
2.	A textbook on petrochemicals, Rao, B., 2004, Khanna.
3.	Petroleum refining technology, Prasad, R., 2000, Khanna.
4.	Petroleum processing handbook [Book chapter], Bland, W. F., & Davidson, R. L.

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	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: V		
HETEROGENEOUS REACTION SYSTEMS (Theory)		
Course Code: MVJ21CH554		**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		
To impart knowledge on different types of catalysis and heterogeneous reactions, Transport processes and industrial catalytic process under isothermal and non-isothermal conditions.		

UNIT-I	
Introduction to catalysis and heterogeneous reactions: general definition of catalysts, solid catalysts, components of catalyst, industrial catalysts, preparation of solid catalysts, precipitation and co-precipitation methods, sol gel method, supported catalysts, impregnation and ion exchange method, catalyst drying calcinations and formulations, catalyst characterization techniques, structural analysis, chemisorption technique, thermal analysis, spectroscopic techniques, microscopic technique.	**8 Hrs**
UNIT-II	
Kinetics of heterogeneous catalytic reactions: reaction mechanism and rate equations, power law model, Langmuir-Hinshelwood –Hougen- Watson (lhhw) model, Eeyrideal model, rate controlling step, estimation of model parameters, reactor types- fixed bed reactor, fluidised bed reactor, berty reactor, multiphase reactors- slurry reactor, trickle bed reactor, bioreactors, catalysts tests.	**8 Hrs**
UNIT-III	
Transport processes with reactions catalyzed by solids: effect of external transport on catalytic reaction rate, effect of external mass transfer resistance on order of reaction, effect of external transport on selectivity, effect of internal mass transport on catalytic reaction rate, bulk diffusion, knudsen diffusion, surface diffusion, effectiveness factor at isothermal conditions, significance of intrapellet diffusion, effect of intrapellet mass transfer on activation energy.	**8 Hrs**
UNIT-IV	
Catalyst deactivation: types of catalyst deactivation, the kinetics of catalyst poisoning, kinetics of catalyst deactivation by coke formation.	**8 Hrs**
UNIT-V	
Industrial catalytic processes: steam reforming, catalytic cracking, three lumped kinetic model for catalytic cracking of gas oil hydrocracking, hydrogenation, and dehydrogenation catalytic reactions.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Derive the rate expressions for heterogeneous catalytic reactions and Catalytic deactivation.
CO2	Develop the rate equations for heterogeneous fluid particle systems and the fluid-fluid noncatalytic reactions to solve problems.
CO3	Analyze different steps in reaction mechanisms on solid catalytic surfaces and identify the factors affecting the rate.

CO4	Derive the Kinetics of Catalyst Deactivation for different industrial applications.
CO5	Derive the performance equation of solid catalysed reaction in various reactors with industrial application of green catalysis.

Reference Books	
1.	Chemical reactor analysis and design, Froment, G. F., Bischoff, K. B., & De Wilde, J., 1990, New York: Wiley.
2.	Elements of chemical reaction engineering, Fogler, H. S., & Fogler, S. H., 1999, Pearson Education.
3.	Chemical reaction engineering, Levenspiel, O., 1998, John wiley & sons.
4.	Fundamentals of chemical reaction engineering, Davis, M. E., & Davis, R. J., 2012, Courier Corporation.

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	**3**	**3**	**2**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**2**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**2**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: V		
ENVIRONMENTAL STUDIES		
Course Code: MVJ21CH56		**CIE Marks: 50**
Credits: L:T:P: 1:0:0		**SEE Marks: 50**
Hours: 15 L		**SEE Duration: 3 Hrs.**
Course Learning Objectives: The students will be able to		
1	Relate interdisciplinary approach to complex environmental problems using basic tools	

	of the natural and social sciences including geo-systems, biology, chemistry, economics, political science and international processes.
2	Study drinking water quality standards and to illustrate qualitative analysis of water.
3	Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability.

UNIT-I	
Introduction to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development. **Ecosystems (Structure and Function):** Forest, Desert, Rivers, Ocean **Biodiversity:** Types, Hot spots; Threats and Conservation of biodiversity, Deforestation**.**	**3 Hrs**
UNIT-II	
Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, Tidal and Wind. **Natural Resource Management (Concept and case-study):** Disaster Management, Sustainable Mining and Carbon Trading.	**3 Hrs**
UNIT-III	
Environmental Pollution: Surface and Ground Water Pollution, Noise pollution, Soil Pollution and Air Pollution. **Waste Management & Public Health Aspects:** Bio-medical Waste, Solid waste, Hazardous waste and E-waste.	**3 Hrs**
UNIT-IV	
Global Environmental Concerns (Concept, policies, and case-studies): Global Warming, Climate Change, Acid Rain, Ozone Depletion and Fluoride problem in drinking water.	**3 Hrs**
UNIT-V	
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems.	**3 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.
CO2	Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
CO3	Demonstrate ecology knowledge of a complex relationship between biotic and Abiotic components.
CO4	Apply their ecological knowledge to illustrate and graph a problem.

Reference Books	
1.	Principals of Environmental Science and Engineering, Raman Siva kumar, 2005, 2nd Edition, Cengage learning, Singapur.
2.	Environmental Science – working with the Earth G.Tyler Miller Jr. Thomson Brooks /Cole, 2006, 11th Edition.
3.	Textbook of Environmental and Ecology, Pratiba Singh, Anoop Singh & Piyush Malaviya, 1st Edition, ACME Learning Pvt. Ltd. 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**--**	**2**	**2**	**1**	**1**	**--**	**2**	**1**
CO2	**3**	**3**	**2**	**1**	**--**	**1**	**2**	**--**	**1**	**1**	**2**	**1**
CO3	**3**	**3**	**2**	**1**	**--**	**2**	**2**	**--**	**1**	**1**	**2**	**1**
CO4	**3**	**3**	**2**	**2**	**--**	**2**	**2**	**--**	**1**	**1**	**2**	**1**
CO5	**3**	**3**	**2**	**2**	**--**	**2**	**2**	**--**	**1**	**1**	**2**	**1**

High-3, Medium-2, Low-1

Semester: V		
RESEARCH METHODOLOGY AND IPR		
Course Code:	**MVJ21RMI57**	**CIE Marks:50**
Credits: L:T:P:S:	**1:2:0:0**	**SEE Marks: 50**
Hours:	**30**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To give an overview of the research methodology and explain the technique of defining a research problem and explain the basic ethics in research.	
2	To develop a suitable outline for research studies through various sources of information from literature review and data collection.	
3	To develop an understanding of the results and on analysis of the work carried.	
4	To Demonstrate enhanced Scientific writing skills.	
5	To Develop an Understanding on Various Intellectual Property Rights and importance of filing patents.	

UNIT-I	
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem. ***Ethics in Engineering Research:*** Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.	**6 Hrs**
UNIT-II	
Research Writing and Journal Publication Skills: Understanding the importance of quality research papers, Differences between conference papers, journal articles, and other academic publications, criteria for selecting a journal, understanding impact factors and journal rankings. place of the literature review in research, how to review the literature, structure of a research paper, effective use of figures and tables, preparing a cover letter and author contributions, Responding to reviewers' comments. **Attributions and Citations:** Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Tools for citation management, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.	**6 Hrs**
UNIT-III	
Research Design: Meaning of Research Design, Need for Research Design,	**6 Hrs**

Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ***Results and Analysis:***Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.	
UNIT-IV	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	**6 Hrs**
UNIT-V	
Introduction to Intellectual Property Rights: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights. Kinds of Intellectual property rights—Copy Right, Patent, Trademark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge. Patents: Trips Definition, Patentable and Non-Patentable inventions, Legal requirements for patents. Patent application process: Prior art search, Drafting of a patent, Filing of a patent, Patent document: specification and claims, Granting of patent, Management of IP, Commercialization of IP – Assignment, licensing and infringement.	**6 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	formulate the research problem and follow research ethics.
CO2	carryto carrying out a Literature survey for the topic identified
CO3	Analyse the research and interpret the outcomes of the research.
CO4	Enhance their technical writing skills
CO5	Understand the importance of Patenting, Licensing and technology transfer.

Text Books	
1.	**C.R. Kothari, Research Methodology, Methods and Techniques, 2nd Revised edition,** New Age International Publishers, 2015
2.	**Neeraj Pandey and Khushdeep Dharni, Intellectual Property Rights, PHI Learning Pvt Ltd, 2014**

Reference Books	
1.	Geoffrey Marczyk, David De Matteo, David Festinger (2005) Essentials of Research Design and Methodology, John Wiley & Sons, Inc.
2.	Carol Ellison (2010) McGraw-Hill's Concise Guide to Writing Research Papers, McGraw-Hill
3.	Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, Ess Publications. 2nd volume.
4.	Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing

Assessment Details (both CIE and SEE)

· The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.

· The student has to obtain a minimum of 40% of maximum marks in CIE and a minimum of 40% of maximum marks in SEE.

· Semester End Exam (SEE) is conducted for 50 marks (2 hours duration).

· Based on this grading will be awarded.

· The student has to score a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

· Three Unit Tests each of 30 Marks (30 MCQ's) (duration 01 hour)

1. First test at the end of 5th week of the semester.

2. Second test at the end of the 10th week of the semester.

3. Third test at the end of the 15th week of the semester.

· Report Writing /Presentation/ Assignment to attain the COs and POs for 20 Marks, (Students can decide the topic for Mini Project and start doing literature survey, report of literature survey can be considered for assignments) At the end of the 13th week of the semester

· The average of three tests and report writing/presentation/Assignment summing to 50 marks

Semester End Examination:

· Theory SEE will be conducted by College as per the scheduled timetable, with common question paper for the subject

· SEE paper will be set for 50 questions of each of 01 mark. The pattern of the question paper is MCQ. The time allotted for SEE is 02 hours

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

High-3, Medium-2, Low-1

Semester: V		
UNIVERSAL HUMAN VALUES (Theory)		
Course Code: MVJ21UHV58		**CIE Marks:50**
Credits: L:T:P: 2:0:0		**SEE Marks: 50**
Hours: 30L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2	Facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3	Highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

UNIT-I	
Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations. **Practical Sessions**: (1) Sharing about Oneself (2) Exploring Human Consciousness (3) Exploring Natural Acceptance	**6 Hrs**
UNIT-II	
Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health. **Practical Sessions**: (4) Exploring the difference of Needs of Self and Body (5) Exploring Sources of Imagination in the Self (6) Exploring Harmony of Self with the Body	**6 Hrs**
UNIT-III	
Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order. **Practical Sessions**: (7) Exploring the Feeling of Trust (8) Exploring the Feeling of Respect (9) Exploring Systems to fulfill Human Goal.	**6 Hrs**
UNIT-IV	
Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders	**6 Hrs**

of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence. **Practical Sessions**: (10) Exploring the Four Orders of Nature (11) Exploring Co-existence in Existence	
UNIT-V	
Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession **Practical Sessions**: (12) Exploring Ethical Human Conduct (13) Exploring Humanistic Models in Education (14) Exploring Steps of Transition towards Universal Human Order	**6 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore themselves, get comfortable with each other and with the teacher.
CO2	Enlist their desires and the desires are not vague.
CO3	Restate that the natural acceptance (intention) is always for living in harmony, only competence is lacking.
CO4	Differentiate between the characteristics and activities of different orders and study the mutual fulfillment among them.
CO5	Present sustainable solutions to the problems in society and nature.

Reference Books	
1.	AICTE SIP UHV-I Teaching Material, https://fdp-si.aicte india.org/ AicteSipUHV download.php
2.	A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
3.	Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2
4.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

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	--	**1**	--	--	--	**2**	**2**	**3**	**2**	**1**	**2**	**1**
CO2	--	**1**	--	--	--	**2**	**2**	**3**	**2**	**1**	**2**	**1**
CO3	--	**1**	--	--	--	**2**	**2**	**3**	**2**	**1**	**2**	**1**
CO4	--	**1**	--	--	--	**2**	**2**	**3**	**2**	**1**	**2**	**1**
CO5	--	**1**	--	--	--	**2**	**2**	**3**	**2**	**1**	**2**	**1**

High-3, Medium-2, Low-1

Semester: VI		
Process Engineering and Economics (Theory)		
Course Code: MVJ21CH61		**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 study various phases in process design & development.
2	To determine cost involved in various processes.
3	Estimation of capital cost, alternative investments and replacement analysis.
4	To study direct, indirect expenses involved and profitability evaluation methods.
5	To study various financial statements, significance of financial ratios and cash flow diagram.

UNIT-I	
Process design development: Process Planning, Feasibility studies and Material & energy balance, Equipment sizing and Material Selection, Analysis of Process flow sheet, Plant layout and location, Factors affecting plant design.	**8 Hrs**
UNIT-II	
Cost analysis: Elements of project cost - cost information, Factors affecting investment & production cost, Estimation of capital investment, operation costs, project financing, Factors in capital investment, Estimation of working capital, cost index, taxes and insurance. **Time value of money:** Types of interests, Effective and nominal interest rates, present worth and discount.	**8 Hrs**
UNIT-III	
Depreciation & taxes: Types of Depreciation and calculation methods **Profitability:** Profitability, Cash flow diagrams, break even analysis, measures of process profitability, methods of evaluation of profitability - Rate of return on investment, Discounted cash flow based on full-life performance, Net present worth, Capitalized costs, Payout period, Simplified model for economic analysis of process design.	**8 Hrs**
UNIT-IV	
Replacements: Theory of replacements, causes for replacements types of replacements, Replacement of Existing Asset with a New Asset **Alternative investments:** Theory of alternative investments and causes for the same. **INFLATION:** Impact, Procedure to Adjust, Economic Life Determination	**8 Hrs**
UNIT-V	
Financial statements: Introduction to financial statements, Cash flow diagrams,	**8 Hrs**

balance sheet and Break-even analysis. **Equipment cost and design report:** Heat transfer equipment costs, Mass transfer equipment costs, Plate and packet towers, dryers, cost estimation for reactor equipment components, cost of piping. **Design report**: Introduction to design of reports. Types of reports, Organization of report and purpose of report.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Discuss basic aspects of process development and economics, process flow sheet.
CO2	Explain the concepts of elements of project costing and time value of money.
CO3	Calculate various cost elements and draw cash flow diagrams and economic analysis of process design.
CO4	Explain theory of replacements and alternative investments and determine optimum cost and rate of product.
CO5	Discuss financial statements, breakeven analysis and prepare design reports, and determine equipment and piping costs.

Reference Books	
1.	Banga, T.R. and Sharma, S.C. (1999). Industrial Organization & Engineering Economics 22nd Edition. (Khanna Publishers).
2.	Peters, M. S., Timmerhaus, K. D., & West, R. E. (2003). Plant design and economics for chemical engineers (Vol. 4). New York: McGraw-Hill.
3.	Happel, J. and Jordan, D.J. Chemical Process Economics. (Marcal Dekker Inc.) ISBN: 0824761553, 2005.

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	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: VI		
CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING (Theory and Practice)		
Course Code: MVJ21CH62		**CIE Marks:50+50**
Credits: L:T:P: 2:2:2		**SEE Marks: 50 +50**
Hours:40 L+26P		**SEE Duration: 03+03 Hours**

Course Learning Objectives: The students will be able to	
1	To study various phases in process design & development.
2	To determine cost involved in various processes.
3	Estimation of capital cost, alternative investments and replacement analysis.
4	Understand the chemical engineering principles applicable for designing chemical engineering equipment
5	To study how to calculate about profitability, depreciation& taxes.

UNIT-I	
Introduction: chemical engineering plant design, general overall design considerations, 5 factors effecting profitability of investments. optimum design: optimum economic design, optimum operating design, the design approach Process Design Development: design project procedure; types of designs, design information from the literature.	**10 Hrs**
UNIT-II	
Equipment design and Specification: factors in equipment scale up and design, safety factors, materials of constructions, health and safety hazards; sources of exposure, exposure evaluation, safety regulation.	**10 Hrs**
UNIT-III	
Mechanical design of process equipment: Design of Cylindrical and Spherical Vessels under internal pressure, heads and closures and tall vessels	**10 Hrs**
UNIT-IV	
Heat transfer equipment design: Basic theory of heat transfer in exchangers, determination of heat transfer coefficients and pressure drop in heat exchangers, selection of heat exchange equipment, design of key heat exchangers (double pipe and shell & tube exchangers).	**10 Hrs**
UNIT-V	
Process Design of Distillation column: Design of sieve tray Distillation column. Types of reactors, process design of batch reactor and continuous flow reactors, selection of reactors, mechanical features of reactor design.	**10 Hrs**
LABORATORY EXPERIMENTS	
1. Sectional views: Representation of the sectional planes 2. Sectional views: Sectional lines and hatching 3. Sectional views: Selection of section planes 4. Sectional views: Types of sectional views 5. Proportionate drawings: Equipment and piping symbols	

6. Vessels components: Vessel openings
7. Vessels components: Manholes
8. Vessels components: Vessel enclosures
9. Vessels components: Vessel support
10. Vessels components: Jackets, Shell and tube heat exchanger.
11. Reaction vessel with the help of solid edge software and different types of Evaporators.
12. P & I Diagrams.
13. Assembly drawings: Joints: Cotter joint with sleeve
14. Assembly drawings: Joints: Socket and Spigot joint
15. Assembly drawings: Joints: Flanged pipe joint
16. Assembly drawings: Joints: Union joint
17. Assembly drawings: Joints: Stuffing box and Expansion joint (Screw type or flanged type).

Any 12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop an understanding for the general designs considerations.
CO2	Understanding of materials cost and handling.
CO3	Evaluation of costs and assets and insurances.
CO4	Apply chemical engineering principles to design chemical process equipment applicable for heat and mass transfer operations.
CO5	Understand design procedure of chemical process equipment.

Reference Books	
1.	The Chemical Process Industries Infrastructure: Function and Economics, James Riley Couper, First Edition, 2000, CRC Press USA, ISBN:9788123910826
2.	Plant design and economics for chemical engineers, Peters, M. S., Timmerhaus, K. D., & West, R. E, Fifth Edition, 2003, New York: McGraw-Hill, ISBN: 9780072392661
3.	Unit Operations in Chemical Engineering, Warren L. McCabe & Julian C. Smith & Peter Harriott, Seventh Edition, 2017, India: McGraw Hill Education, ISBN:9339213238
4.	Chemical process economics, Happel, J. and Jordan, D.J. FirstEdition, 2005, New Yark: Marcal Dekker Inc., ISBN:0824761553

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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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.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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	**3**	**3**	**2**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: VI		
MASS TRANSFER – II (Theory and Practice)		
Course Code: MVJ21CH63		**CIE Marks:50+50**
Credits: L:T:P 2:2:2		**SEE Marks: 50 +50**
Hours:40 L+ 26 P		**SEE Duration: 03+03 Hours**

Course Learning Objectives: The students will be able to	
1	Be able to understand different separation techniques.
2	Acquire the knowledge of separation processes like distillation, adsorption, and extraction.
3	Be able to use the phase equilibrium concepts in mass transfer related problems.
4	Be able to design staged /packed column for mass transfer operations.
5	Be able to design distillation column, absorber and calculations involved in liquid-liquid extraction.

UNIT-I	
Gas Liquid Contacting Systems: Types, construction and working of plate and packed columns, types and properties of industrial packing's, plate efficiencies, HETP and HTU concepts. Absorption: Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and desorption factors.	**8 Hrs**
UNIT-II	
Packed Tower Absorption: Liquid phase hold up and pressure drop in absorption towers. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction. Distillation: Introduction. Vapour liquid equilibria (T-x,y, P-x,y. H-x,y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Atmospheric distillation, Flash and simple distillation, Distillation in a packed tower.	**8 Hrs**
UNIT-III	
Distillation (Contd.): Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorel methods for binary mixtures. Distillation (Contd.): Ponchon- Savarit method. Introduction to Multi component distillation, Vacuum, molecular, extractive and azeotropic distillations.	**8 Hrs**
UNIT-IV	
Liquid-Liquid Extraction: Ternary equilibrium. Solvent selection. Single stage and multi-stage cross-current, counter-current extraction. Equipment for liquid-liquid extraction, fractional extraction.	**8 Hrs**
UNIT-V	
Leaching Operation: Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching	**8 Hrs**

operation.	

LABORATORY EXPERIMENTS

1. Determination of diffusivity
2. Verification of Rayleigh's equation by conducting simple distillation
3. Determination of HETP using packed column distillation
4. Study the characterization of steam distillation
5. Solid – liquid leaching: Single stage and three stage cross current
6. Verification of Himus equation
7. Study the drying characteristics in a tray dryer
8. Adsorption studies: single stage and two stage cross-current operation
9. Determination of Vapour Liquid Equilibrium (VLE)data
10. Liquid extraction: single stage and three stage cross current operation
11. Hold up studies in packed columns
12. Study the drying characteristics in a vacuum dryer
13. Determination of mass transfer coefficient by conducting wetted wall column experiment
14. Measurement of cooling tower characteristic parameter
15. Solid dissolution Studies
16. Separation of DNA using Gel-electrophoresis experiment
17. Casting of membrane

Any 12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the concepts of HETP, NTU and HTU to design various gas-liquid contacting systems.
CO2	Apply the concept of absorption to calculate the number of plates and height of continuous absorber.
CO3	Estimate the composition of distillate and residue using VLE data and explain the different distillation processes.
CO4	Apply McCabe Thiele, Ponchon - Savarit method and Lewis-Sorel methods for multi component mixtures to calculate no of trays in multi-stage rectification column.
CO5	Develop equations for the material balance for stage wise operations in liquid-liquid extraction and leaching operations and working of the equipment.

Reference Books	
1.	Mass transfer operations, Treybal, R. E.,Third Edition, 2017, New York: McGraw Hill Education,ISBN:1259029158
2.	Unit Operations in Chemical Engineering, McCabe & Smith, Seventh Edition, 2017, New York: McGraw Hill Education,ISBN:9339213238
3.	Principles of unit operations, Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., & Andersen, L. B., Second Edition, 2008, John Wiley & Sons.ISBN:9788126518296
4.	Chemical Engineering, Coulson and Richardson, Third Edition, 1999, Pergamon Press., ISBN:0750641428

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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 complete 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	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

High-3, Medium-2, Low-1

Semester: VI		
INDUSTRIAL POLLUTION AND CONTROL (Theory)		
Course Code: MVJ21CH641		**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	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- metallurgical industries, and cement industries.	**8 Hrs**
UNIT-V	
Solid Waste Management: Origin, classification and microbiology. Engineered systems for solid waste management – generation, onsite handling, storage,	**8 Hrs**

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.	

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

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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	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	2	2	2	--	--	2	--

High-3, Medium-2, Low-1

Semester: VI		
NANOSCIENCE & NANOTECHNOLOGY (Theory)		
Course Code: MVJ21CH642		**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 behavior of various smart materials and its applications.
2	Understand basics and synthesis of nano materials and their properties.
3	Learn to analyze and assess parameters involved in synthesis and characterization.
4	Understand the synthesis techniques at nanoscale.
5	Understand the applications of nano technology in various fields.

UNIT-I	
Introduction and scope - Introduction to nanoscale, history, evolution of various disciplines towards nanoscale potential applications, recent achievements in nanotechnology, short-term commercial nanotechnology products, specific applications, challenges and opportunities, technology scope, areas and sub disciplines, commercialization scope, present course of investigation.	**8 Hrs**
UNIT-II	
Basic nanotechnology science: Introduction, approach & scope, sub atomic particles, basic entities/particles of interest, basic physics terms of interest, scale of atomic entities, atomic distances, elementary and non-elementary particles, key physical properties of elements, basic properties of silicon and basics of transistor operations: transistor, manufacturing approaches, manufacturing limitations.	**8 Hrs**
UNIT-III	
Nanomaterials: Synthesis and Characterization: Introduction, basic nanostructures: CNTs, nanowires, nanocones; quantum dots, quantum dot nanocrystals, ultra-nanocrystalline diamond, nanocomposites, thin films, nanofoams, nanoclusters, smart nanostructures. Characterization of Nano materials: Microscopy-Scanning tunnelling microscope, atomic force microscope, scanning electron microscopy, Field Emission Scanning Electron Microscopy (FESEM), Transmission Electron Microscopy (TEM), Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM), Surface enhanced Raman Spectroscopy, X-ray diffraction technique, X ray Photoelectron Spectroscopy Surface area analysis, particle size analysis, gravimetric analysis.	**8 Hrs**
UNIT-IV	
Nanoscale Manufacturing: Nano manipulation, Nanolithography- Optical lithography, Photolithography, Dip pen nanolithography, Extreme UV Lithography, Electron beam (e-beam) lithography, Epitaxial Growth: classical growth modes, techniques for epitaxy: Liquid Phase Epitaxy (LPE), Physical Vapor	**8 Hrs**

Deposition (PVD), Molecular Beam Epitaxy (MBE). Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), Self-Assembly.	
UNIT-V	
Application of Nanotechnology: Environment: remediation and mitigation using metal oxide nano particles, magnetic particles, Nanomembranes and nanofilters, Pollution prevention: nanocatalysis, environmental sensors Medicine and healthcare: diagnosis, biosensors, drug delivery, therapy Energy: Solar energy-Photovoltaics, Dye-sensitised solar cell, Quantum-dot- sensitized solar cells. Hydrogen energy-Hydrogen production and Hydrogen storage, hydrogen fuel cell, Energy Savings-Insulators and smart coatings, Energy- harvesting materials, Information and communication technologies: Integrated circuits, Data storage, Photonics, Displays, Information storage devices, Wireless sensing and communication.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the concept of nano and its opportunities in various fields
CO2	Understand the basic science of basic nano technology
CO3	Identify various nano materials and recall nano materials synthesis, characterization techniques
CO4	Identify various nano manufacturing techniques.
CO5	Understand the applications of Nano technology in various fields.

Reference Books	
1	A textbook of nanoscience and nanotechnology, Varghese, P. I., & Pradeep, T., 2003, Tata McGraw-Hill Education.
2	Nanotechnologies: principles, applications, implications and hands-on activities: A compendium for educators, Fiiipponi, L., & Sutherland, D., 2012, European Union, Directorate General for Research and Innovation.
3	Nano Materials, Bandyopadhyay. K., 2007, First edition, New Age International Publishers.
4	An introduction: material science and engineering, Callister, W. D., 2007, 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	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**--**	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**--**	**3**	**1**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**--**	**--**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**--**	**3**	**1**	**2**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: VI		
RENEWABLE ENERGY: RESOURCES AND TECHNOLOGIES (Theory)		
Course Code: MVJ21CH643		**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	Study the technologies for harvesting renewable technology.	
2	Study photovoltaic's, wind power, hydropower, biomass energy, solar thermal power.	
3	Know about comparison of characteristics and cost of renewable.	
4	Understand energy audits and residential energy audits.	
5.	Understand the developing technology.	

UNIT-I	
Current Practices and Future Sustainability: Introduction to renewable energy: fundamentals and its impact on society and the environment, advantages and disadvantages of renewable energy sources, energy conservation and audits, zero waste technology, waste to wealth, sustainability, sources of renewables, comparison of characteristics and cost of renewables. Cleaner Production: Technologies for the clean energy production from the renewable materials.	**8 Hrs**
UNIT-II	
Photovoltaics, Solar thermal power, Solar Radiation, and Its Measurement: Solar constant, solar radiation at the earth's surface, solar radiation geometry, solar radiation measurements, applications of solar energy, solar water heating, space-heating (or solar heating of buildings), space cooling (or solar cooling of a building), solar thermal electric conversion, agriculture and industrial process heat, solar distillation, solar pumping, solar cooking. Geothermal energy, resource identification and development, geothermal power generation systems, geothermal power plants, case studies.	**8 Hrs**
UNIT-III	
Energy from biomass (bioenergy): Introduction, biomass conversion technologies, wet processes, dry processes, biogas generation, factors affecting bio-digestion, types of biogas plants (KVIC model & Janata model), selection of site for biogas plant. Bioenergy (thermal conversion): Methods for obtaining energy from biomass, thermal gasification of biomass, classification of biomass gasifiers, chemistry of the gasification process, applications of the gasifiers.	**8 Hrs**
UNIT-IV	
Wind energy: Introduction, basic components of WECS (wind energy conversion system), classification of WEC systems, types of wind machines (wind energy collectors), horizontal-axial machines and vertical axis machines. OTEC-Introduction, ocean thermal electric conversion (OTEC), methods of ocean	**8 Hrs**

thermal electric power generation, open and closed cycle OTEC system. Hybrid cycle energy from tides: Basic principles of tidal power, components of tidal power plants, operation methods of utilization of tidal energy, advantages and limitations of tidal power generation.	
UNIT-V	
Hydrogen as a Fuel: Introduction, methods of hydrogen production (principles only), storage, transportation, utilization of hydrogen gas, hydrogen as alternative fuel for motor vehicle, safety and management. Hydrogen technology development in India.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Developed concept about the various forms of energy
CO2	Comprehend about the principles of various forms of renewable energy
CO3	Apply the concept of zero waste, atom economy for waste management
CO4	Hands on learning to produce hydrogen from the feedstock.
CO5	Explains the various methods for hydrogen production, storage and transportation.

Textbooks:	
1	Non-conventional energy resources,.Rai, G. D., 2004, Khpu Khanna, India, 369, 331-337.
2	Renewable energy resources, Twidell, J., & Weir, T., 2015, Routledge.
3	Renewable energy: power for a sustainable future, Boyle, G., 1996, Oxford University Press.
4	Energy systems and sustainability: power for a sustainable future, Everett, R., Boyle, G., Peake, S., & Ramage, J., 2012, Oxford University Press.

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	1	--	--	--	1	2	1	--	1	--	1
CO2	2	1	--	--	--	1	2	--	--	--	--	1
CO3	1	2	1	2	1	3	3	3	2	1	1	--
CO4	2	1	2	2	--	--	2	--	--	1	3	--
CO5	2	1	--	--	--	1	2	--	--	--	--	1

High-3, Medium-2, Low-1

Semester: VI		
FOOD TECHNOLOGY (Theory)		
Course Code: MVJ21CH644		**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 knowledge to the students about food processing and various unit operations.
2	Understand the knowledge of formation of foods.
3	Understand the concepts of enzymatic reactions.
4	Gain knowledge on the preservatives and additives.
5	Know the importance of the food safety.

UNIT-I	
Introduction and Quality Attributes of Food: Function of foods. Food in relation to health. Aim of food science and technology. Quality attributes – Appearance factors, Textural factors, Flavor factors. Visual and objectively measurable attributes. Aroma of foods – introductory ideas, formation, chemistry and analysis. Taste – introductory ideas, formation and chemistry. Additional quality; quality standards, quality control. Introduction to sensory evaluation of foods and beverages. Modern Trends In Food Science: Biotechnology in food. Biofortification, Nutraceuticals. Organic foods. Low cost nutrient supplements. Packaging of foods and nutrition labeling. Careers in food science and food industries.	**8 Hrs**
UNIT-II	
Formation and Chemistry of Food: Carbohydrates. Proteins. Lipids. Vitamins. Minerals. Water. Biotin. Choline. Phytochemicals. Food Processing and Preservation: Food deterioration – Causes. Aims and objectives of preservation and processing. Unit operations in processing. Different methods of food preservation – low temperature, high temperature, preservatives, osmotic pressure, dehydrations. food irradiation; processing and preservations of milk and dairy, vegetables and fruits, cereals, legumes and nuts, meat and meat products, fats and oils, beverages, sugars, sweeteners, honey and confectionary, salt and spices.	**8 Hrs**
UNIT-III	
Enzymatic and Non-Enzymatic Reactions During Storages: Introduction to enzymes. Nature and function of enzymes. Classification of enzymes. Hydrolases – Esterases, amylases, pectic enzymes. Proteases. Oxidoreductases – phenolases, glucose oxidase, catalase, peroxidase, lipoxygenase, xanthine oxidase. Immobilized enzymes. Uses and suggested uses of enzyme in food processing. Non-enzymatic reactions.	**8 Hrs**
UNIT-IV	
Food Additives: Introduction and need for food additives. Types of additives –	

antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humectants and anti-choking agents, leavening agents, nutrient supplements, non- nutritive sweeteners, pH control agents. Preservatives – types and applications. Stabilizers and thickeners, other additives. Additives and food safety. Food Contamination and Adulteration: Types of adulterants and contaminants. Intentional adulterants. Metallic contamination. Incidental adulterants. Nature and effects. Food laws and standards.	
UNIT-V	
Environmental Concerns and Food Safety: Water in food production. Properties and requirements of processing water. Environmental concerns – solid waste disposal, wastewater properties, wastewater treatment. Safety hazards and risks. Food related hazards. Processing and handling. Cleaning and sanitizing.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the quality attributes and chemistry of foods
CO2	Apply principles of packaging, storing and preservation, food poisoning, food related hazards and safety
CO3	Explain the various causes of food deterioration and food poisoning.
CO4	Identify appropriate processing, preservation, and packaging method.
CO5	Analyze product quality and effect of processing technique on it.

Reference Books	
1	Food Science, B. Srilakshmi, 2007, 4th edn, New Age International.
2	Foods: Facts and Principles, N. Shakuntala Manay and M. Shadaksharamurthy, 2005, New Age Publishers.
3	Introduction to Food Science, Rick Parker, 2001, Thomsan Detmer.
4	Food Processing and Preservation, G. Subbulakshmi and Shobha A. Udupi, 2001, New Age International.

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	3	3	3	--	3	--	--	--	--	--	--	--
CO2	3	3	3	--	3	--	--	--	--	--	--	1
CO3	3	3	3	--	3	--	--	--	--	--	--	2
CO4	3	3	3	--	3	--	--	--	--	--	--	2
CO5	3	3	3	--	3	--	--	--	--	--	--	2

High-3, Medium-2, Low-1

Semester: VI		
AEC6: DATA ANALYTICS FOR CHEMICAL ENGINEERS (Theory)		
Course Code: MVJ21CH66		**CIE Marks:50**
Credits: L:T:P: 1:0:0		**SEE Marks: 50**
Hours: 20L		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Process the big experimental data set for the analysis and finding of specific goal and solution.
2	Understand about statistical analysis and technologies on data to find trends and solve problems.
3	Understand about building a business strategy or ensuring the safety and efficiency of an engineering project.
4	To Learn about the Internet of Things uses and applications.
5	To learn about the data management.

UNIT-I	
Introduction to data science, data analytics, big data, internet of things, relationship between data science and statistics, limitations and failures of data science, methodologies of data science in chemical engineering.	**4 Hrs**
UNIT-II	
Trends in Data science: Experimentation in data science, modelling and computation, machine learning, big data analytics, spreadsheet and data management, relational database management system (RDBM's).	**4 Hrs**
UNIT-III	
Data Science Engineering: Software and applications engineering, data warehousing, big data infrastructure and tools. Data Management and Governance: Data stewardship, curation and preservation	**4 Hrs**
UNIT-IV	
Research methods and project management for research related professions and business process management for business related professions, classification & clustering of data, time series, multivariate statistics, data visualization.	**4 Hrs**
UNIT-V	
Data science in computational molecular science and engineering, energy systems and management, case studies for optimization of production and rejuvenation of oil and gas assets.	**4 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basics of Data science, Big data, Data Analytics and statistics.
CO2	Recent trends in Data science, Relational Data base Management system (RDBM's)
CO3	Explains the Data Management and Governance, Preservation curve and curation.
CO4	Explains the Research Methods and the Process Management for business related Professionals.

CO5	Relational data science in the field of Computational Engineering & Biology.

Reference Books	
1.	Advanced data analysis and modelling in chemical engineering, Constales, D., Yablonsky, G., D'hooge, D. R., Thybaut, J. W., & Marin, G. B., First Edition, 2016, Elsevier, ISBN: 978-0444594853
2.	An introduction to statistical learning, James, G., Witten, D., Hastie, T., &Tibshirani, R., First Edition, 2013, New York: Springer, ISBN: 978-1461471370
3.	Introduction to data mining, Tan, P. N., Steinbach, M., & Kumar, V., First Edition, 2016, Pearson Education India, ISBN: 978-9332571402
4.	Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber, Jian Pei, Third Edition, 2011, Morgan Kaufmann, ISBN: 978-9380931913

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**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO2	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO3	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: VII		
CHEMICAL PROCESS MODELLING AND SIMULATION (Theory and Practice)		
Course Code: MVJ21CH71		**CIE Marks:50+50**
Credits: L:T:P: 2:2:2		**SEE Marks: 50 +50**
Hours:40 L+26P		**SEE Duration: 03+03 Hours**

Course Learning Objectives: The students will be able to	
1	Apply numerical techniques to solve chemical engineering problems.
2	Analyze chemical engineering system in term of modeling principle.
3	Develop simple chemical engineering models.
4	Develop algorithm for modelling & solve the model.
5	Distinguish simulation from design of equipment.

UNIT-I	
Modelling: Models and model building, principles of model formulations, precautions in model building, degree-of-freedom analysis, selection of design variables, review of numerical techniques, model simulation. Review of shell balance approach, continuity equation, energy equation, equation of motion and momentum, transport equation of state equilibrium and kinetics, thermodynamic correlations for the estimation of physical properties like phase equilibrium, bubble, and dew points.	**8 Hrs**
UNIT-II	
Basic formulation of mathematical modelling: Basic tank model – Level V/s time. **Models in separation process:** Batch Distillation – Vapour composition with time, Multistage distillation and multi-component flash drum, solvent extraction (steady & unsteady state), multistage gas absorption.	**8 Hrs**
UNIT-III	
Models in heat transfer operation: Heat conduction through cylindrical pipe (steady & unsteady state), cooling of tanks, and unsteady state heat transfer by conduction. **Models in fluid flow operation:** fluid through packed bed column, flow & film on the outside of a circular tube, laminar flow of Newtonian liquid in a pipe, gravity flow tank.	**8 Hrs**
UNIT-IV	
Models in reaction engineering: Chemical reaction with diffusion in a tubular reactor, gas phase pressurized CSTR, two phase CSTR, reactors in series (constant and variable hold-ups), batch reactor with mass transfer.	**8 Hrs**
UNIT-V	
Simulation of the models, tearing and flow sheeting, modular and equation-solving approach (elementary treatment only). Introduction and use of process simulation software (DWSIM/ASPEN PLUS/ ASPEN HYSYS) for flow sheet simulation.	**8 Hrs**
LABORATORY EXPERIMENTS	

1. Introduction to suggested software available (flow sheeting)
2. Simulation of shell and tube heat exchanger.
3. Simulation of centrifugal pump/compressor.
4. Simulation of flash drum/separator.
5. Simulation of single stream gas heater/cooler.
6. Simulation of CSTR for liquid phase reaction.
7. Simulation of distillation column.
8. Mixing of ideal liquid streams.
9. Generation of VLE data of binary component system.
10. Determination of equilibrium conversion of reversible reactions.
11. Material balance on reactor based on yield/conversion data.
12. Process simulation study involving mixing, reactor, heat exchanger for the following.
13. Ethylene glycol from ethylene oxide.
14. Propylene glycol from propylene oxide.
15. Aromatic stripper with recycle stream (Benzene, Toluene, Xylene).
16. Styrene from ethyl benzene.
17. Process simulation study involving distillation for the atmospheric distillation of crude oil.

Any 12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the various equations to simple chemical engineering problems.
CO2	Develop the modelling equations for chemical engineering problems pertaining to mass transfer.
CO3	Strategies in developing mathematical models for momentum and heat transfer applications.
CO4	Applying the modelling concepts to the transport problems involving chemical reactions.
CO5	Simulate a process using process simulators (DWSIM/ASPEN Plus/ ASPEN Hysys).

Reference Books	
1.	"Process plant simulation", Babu, B. V. First edition, 2004, Oxford University Press, USA. ISBN: 9780195668056.
2.	"Process Modeling Simulation, and Control for Chemical Engineers", William, L., & William, L., Second Edition, 2003, McGraw-Hill Publishing Company.
3.	"Chemical engineering computation with MATLAB", Yeo, Y. K. First edition, 2017, CRC Press, ISBN: 9781315114880
4.	"Fundamentals and Modeling of separation processes: Absorption, distillation, evaporation", Holland, C.D., Fifth edition, 2012, Prentice-Hall, Englewood Cliffs, N.J. ISBN:9780133443905.

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.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are 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	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO5	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

High-3, Medium -2, Low-1

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 methods used in typical industries – coal fired power stations, textile industry, oil refinery, distillery, sugar industry, radioactive and e-waste generation units.	**8 Hrs**

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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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, 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.	**8 Hrs**

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**	**--**
CO2	**2**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**3**	**--**
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,	**8 Hrs**

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	
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- metallurgical industries, and cement industries.	**8 Hrs**
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,	**8 Hrs**

clean technologies.	

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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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, supercritical fluids	**8 Hrs**

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												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
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/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
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-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.	**8 Hrs**
UNIT-V	
Hazards Identification: process hazards checklists, hazards surveys, hazards and operability studies, safety reviews, other methods, risk assessment: review of	**8 Hrs**

probability theory, event trees, fault trees, QRA and LOPA	

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	**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		
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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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
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	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,	**8 Hrs**

Vacancies, Interstitials geometry of dislocation, Schmid´s law, Surface imperfection, Importance of defects, Microscopic techniques – grain size distribution.	
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 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.	**8 Hrs**
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
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**	**1**		**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO2	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
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, 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.	**8 Hrs**

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
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**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**

CO2	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO3	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO4	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO5	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**

High-3, Medium-2, Low-1

Course Title	PROJECT PHASE – II	Semester	VIII
Course Code	MVJ21CHP81	CIE Marks	50
Total No. of Contact Hours	L : T : P :: 0 : 0 : 20	SEE Marks	50
No. of Contact Hours/week	-	Total	100
Credits	10	SEE Duration	3 Hours

Course Objective:

- To support independent learning.
- To develop interactive, communication, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgment, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

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

CO1	Describe the project and be able to defend it. Develop critical thinking and problem solving skills.
CO2	Learn to use modern tools and techniques. Communicate effectively and to present ideas clearly and coherently both in written and oral forms.
CO3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
CO5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Scheme of Evaluation :

Internal Marks: The Internal marks (50 marks) evaluation shall be based on Phase wise completion of the project work, Project report, Presentation and Demonstration of the actual/model/prototype of the project.

Semester End Examination: SEE marks for the project (50 marks) shall be based on Project report, Presentation and Demonstration of the actual/model/prototype of the project, as per the norms by the examiners appointed

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

High-3, Medium-2, Low-1

Course Title	**INTERNSHIP**	**CIE Marks**	50
Course Code	MVJ21CHINT82	**SEE Marks**	50
Total No. of Contact Hours	Industrial Oriented	**Total**	100
No. of Contact Hours/week	-	**SEE Duration**	3 Hours
Credits	5	**CIE Marks**	50

Course Objective:

- To get the field exposure and experience
- To apply the theoretical concept in field application
- To prepare the comparison statement of difference activities

Internship: This shall be carried out by students in industry set-up related to the construction/ materials testing laboratories/research organizations/project management consulting firms/QS and QA organizations/ planning and design offices/Professional organizations and other avenues related to the civil engineering domain in consultation and approval of internship guide/HOD /internship committees of the institutions.

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

CO1	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO2	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
CO3	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Scheme of Evaluation :

Internal Marks: The Internal marks (50 marks) evaluation shall be based on midterm and final presentation of the activities undertaken during the internship, to a panel comprising internship guide, a senior faculty from the department and head of the department. Each student should submit the internship report at the end of semester with internship certificate.

Semester End Examination: Viva-Voce examination shall be conducted by a panel of examiners consisting of internship supervisor, a senior faculty from the department and head of the department.

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**SEMINAR**	**CIE Marks**	50
Course Code	MVJ21CHS83	**SEE Marks**	50
Total No. of Contact Hours	-	**Total**	100
No. of Contact Hours/week	-	**SEE Duration**	3 Hours
Credits	1	**CIE Marks**	50

Course Objective:

- To inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Seminar: Each student, under the guidance of a Faculty, is required to choose, preferably, a recent topic of his/her interest relevant to the course of specialization. Carryout literature survey; organize the Course topics in a systematic order.

- Conduct literature survey in the domain area to find appropriate topic.
- Prepare the synopsis report with own sentences in a standard format.
- Learn to use MS word, MS power point, MS equation and Drawing tools or any such facilities in the preparation of report and presentation.
- Present the seminar topic orally and/or through power point slides.
- Communicate effectively to answer the queries and involve in debate/discussion.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.