Semester: III		
PROBABILITY AND STATISTICS		
Course Code:	**MVJ22CH31**	**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 probability distribution, sampling theory and joint probability distributions. 2. Organize, manage, and present data using statistical method.		

MODULE-I	
Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems. Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.	8Hrs
MODULE-II	
Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution and Chi-square distribution.	8Hrs
MODULE-III	
Markov Chains: States and transitions, Transition probabilities, General two-stateMarkov chain, Powers of the transition matrix for the m-state chain, Gambler's ruin as a Markov chain, Classification of states, Classification of chains, problems.	8Hrs
MODULE-IV	
Statistical Methods Correlation and Regression: Correlation, Regression coefficients, line of regression problems. Curve fitting: Fitting of the curves of the $y = ax + b$, $y = ax^2 + bx + c$, $y =$ by the method of least squares.	8Hrs
MODULE-V	
Design of Experiments (ANOVA): One way and Two way classifications, Completely randomized design, Randomized block design, Latin square design.	8Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, information theory and Design engineering.
CO2	Demonstrate testing of hypothesis of sampling distributions.
CO3	Define transition probability matrix of a Markov chain and solve problems related to discrete parameter random process.
CO4	Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.
CO5	Understand the need and application of analytics.

Reference Books	
1.	B.S. Grewal, “Higher Engineering Mathematics” Khanna Publishers, 43rd Edition, 2013.
2.	Erwin Kreyszig, “Advanced Engineering Mathematics”, Wiley-India publishers, 10thedition,2014.
3.	Fundamentals of Statistics, S C Gupta, Himalaya Publications 2012.
4.	Ramana B. V., “Higher Engineering Mathematics”, Tata Mc Graw-Hill, 2006.
5	"Design and Analysis of Experiments" by Douglas C. Montgomery, Wiley Publishers

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	3	3	--	2	--	--	--	--	--	--	--	1
CO4	3	3	--	3	--	--	--	--	--	--	--	1
CO5	3	2	--	3	--	--	--	--	--	--	--	1

Semester: III		
MOMENTUM TRANSFER (Theory and Practice)		
Course Code:	**MVJ22CH32**	**CIE Marks:50**

Credits: L:T:P	3:0:2	SEE Marks: 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.

MODULE-I	
Fluid statics and its applications – the concept of MODULE 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**
MODULE-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.	**8 Hrs**
MODULE-III	
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. Friction factor chart, friction from changes in velocity or direction, form friction losses in Bernoulli equation, flow of fluids in thin layers	**8 Hrs**

The flow of compressible fluids - continuity equation, Mach number, total energy balance, the velocity of sound, Ideal gas equations, flow through variable-area conduits, adiabatic frictional flow, isothermal frictional flow (elementary treatment only).	
MODULE-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
MODULE-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 meter (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	

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, 5thedn.

Theory for 25 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 25 marks.

Laboratory- 25 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 25.

Semester End Examination (SEE):

Total marks: 25+25=50

SEE for 25 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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
CO2	3	3	3	--	--	--	--	--	--	--	--	1
CO3	3	3	3	--	--	--	--	--	--	--	--	1
CO4	3	3	3	--	--	--	--	--	--	--	--	1
CO5	3	3	3	--	--	--	--	--	--	--	--	1

High-3, Medium-2, Low-1

Semester: III		
MECHANICAL UNIT OPERATIONS (Theory and Practice)		
Course Code:	**MVJ22CH33**	**CIE Marks:50**
Credits: L:T:P:	**3:0:2**	**SEE Marks: 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.	

MODULE-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**
MODULE-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**
MODULE-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**

MODULE-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. **Sedimentation:** Batch settling test, Coe and Clevenger theory, Kynch theory, thickener design, Equipment: Gravity Settling Tank, Disk Bowl Centrifuge.	**8 Hrs**
MODULE-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 process 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.

Theory for 25 Marks

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Laboratory- 25 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 25.

Semester End Examination (SEE):

Total marks: 25+25=50

SEE for 25 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
CHEMICAL PROCESS CALCULATIONS (Theory)		
Course Code:	**MVJ22CH34**	**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		
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		

MODULE-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**
MODULE-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, Psychometric. Simple problems solving using psychometric charts. Evaporation and condensation processes.	**10 Hrs**
MODULE-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**
MODULE-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,	**10 Hrs**

Material balances with and without reactions involving bypass, recycle and purging.	
MODULE-V	
Energy Balance: General energy balance equation for steady state. Thermo chemistry, heat capacity, estimation of heat capacity for solids, liquids, gases and 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.	**10 Hrs**

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 Process Principles. Part I: Material and Energy Balances, Hougen, O. A., Watson, K. M., and 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**3**	**3**	**1**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**3**	**1**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**1**
CO5	**3**	**3**	**3**	**1**	**--**	**1**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: III		
Computer Aided Drawing Lab		
Course Code:	**MVJ22CHL35**	**CIE Marks:50**
Credits: L:T:P	**0:0:2**	**SEE Marks: 50**
Hours:	**26P**	**SEE Duration: 03 Hours**

Course Learning Objectives: The students will be able to

1. Demonstrate basic concepts of the computer aided drawing software
2. Apply basic concepts to develop construction (drawing) techniques
3. Ability to manipulate drawings through editing and plotting techniques
4. Understand geometric construction, Produce 2D Orthographic Projections
5. Understand and demonstrate dimensioning concepts and techniques, Section and Auxiliary Views

LABORATORY EXPERIMENTS

1. INTRODUCTION TO SECTIONAL VIEWS: Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.
2. PROPORTIONATE DRAWINGS: Equipment and piping symbols
3. VESSEL COMPONENTS: Vessel openings, Manholes
4. Vessel enclosures, Vessel support, Jackets
5. Shell and tube heat exchanger,
6. Reaction vessel
7. Different types of Evaporators.
8. P & I Diagrams

ASSEMBLY DRAWINGS:

9. Cotter joint with sleeve
10. Socket and Spigot joint
11. Flanged pipe joint
12. Union joint (Demonstration)
13. Stuffing box (Demonstration)
14. Expansion joint (Screw type or flanged type) (Demonstration)

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze the general projections of given object.
CO2	Represent two-dimensional proportionate drawings of process symbols of various pipes and fittings.
CO3	Demonstrate the proportionate drawings of reaction vessel, jacketed vessels, evaporator, STHE and DPHE
CO4	Identify the parts of industrially used equipment.
CO5	Draw the assembly drawings of socket and spigot, flanged pipe and union joints showing sectional, front, top, and side

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.

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

High-3, Medium-2, Low-1

Semester: III		
MATERIAL SCIENCE & TECHNOLOGY (Theory)		
Course Code:	**MVJ22CH361**	**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	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-IV	
Corrosion and its Prevention: corrosion and its manifestations, consequences, direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factors influencing corrosion rate, control and prevention of corrosion-modification of corrosive environment, inhibitors, protective coatings, Specific types of corrosion	**8 Hrs**
MODULE-V	
Typical Engineering materials: Ferrous metals, non-ferrous metals and alloys, Aluminum 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	**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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO2	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO3	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO4	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**
CO5	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2**

High-3, Medium-2, Low-1

Semester: III		
CARBON SEQUESTRATION TECHNOLOGY		
Course Code:	**MVJ22CH362**	**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 concept of carbon sequestration and its significance in mitigating climate change.	
2	Gain knowledge of different carbon capture techniques, including pre-combustion, post-combustion, and oxy-fuel combustion.	
3	Identify and assess various methods of carbon storage, including geological, oceanic, and terrestrial options.	
4	Familiarize with different monitoring techniques used in carbon sequestration projects, including remote sensing, geophysical monitoring, and geochemical monitoring.	
5	Analyze the economic aspects of carbon sequestration projects, including cost estimation, financial incentives, and market mechanisms.	

MODULE-I	
Introduction to Carbon Sequestration: Concept, Importance, and Relevance in Mitigating Climate Change. Sources and sinks of carbon dioxide (CO2): natural and anthropogenic sources; identification of potential carbon sinks. Greenhouse gases (GHGs): Overview of different GHGs, their contributions to global warming, and the role of CO2 as the primary GHG Climate change and its impacts: understanding the consequences of increased CO2 levels, global temperature rise, and climate-related events.	**8 Hrs**
MODULE-II	
Carbon capture techniques: an overview of pre-combustion, post-combustion, and oxy-fuel combustion capture technologies. Pre-combustion capture: coal gasification and syngas cleaning. Post-combustion capture: a detailed study of techniques like absorption, adsorption, and membrane separation. Oxyfuel combustion, Direct air capture.	**8 Hrs**
MODULE-III	
Carbon storage methods: an overview of geological, oceanic, and terrestrial storage options. Enhanced oil recovery (EOR), Saline aquifer storage, and deep geological formations. Ocean-based carbon sequestration methods. Terrestrial storage and utilization: afforestation, reforestation, and carbon farming	**8 Hrs**
MODULE-IV	
Monitoring techniques: an overview of remote sensing, geophysical monitoring, and geochemical monitoring methods	**8 Hrs**

Verification of carbon sequestration projects: understanding the importance of accurate measurement, reporting, and verification (MRV) for carbon credits and compliance. Risk assessment and mitigation: Analyzing potential risks associated with carbon sequestration and developing strategies to mitigate them Legal and regulatory frameworks: discussion of national and international policies governing carbon sequestration projects	
MODULE-V	
Economic analysis of carbon sequestration projects: cost estimation, financial incentives, and market mechanisms like carbon trading and carbon taxes. Life cycle assessment (LCA): evaluating the environmental impact of carbon capture and storage (CCS) technologies. Role of innovation and research: exploring emerging technologies, breakthroughs, and future directions in carbon sequestration Analyzing real-world carbon sequestration projects.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand carbon sequestration as a climate change mitigation method and its relevance to global environmental issues after completing this module.
CO2	Analyze carbon capture technologies, appraise their strengths and weaknesses, and propose suitable capture procedures for specific industrial applications.
CO3	Evaluate carbon storage and utilization systems and choose the best ones based on environmental, economic, and technological factors
CO4	Use various monitoring methods, accurately measure and report carbon sequestration projects, and analyze and manage risks.
CO5	Analyze the economics of carbon sequestration projects, and grasp life cycle evaluation.

Reference Books	
1.	"Carbon Capture and Storage: Physical, Chemical, and Biological Methods" by Chunshan Song and Detlef Stolten
2.	Carbon Capture and Storage: CO_2 Management Technologies" by Shaojun Liu, Yuzhuo Zhang, and Fengwei Yang
3.	"Carbon Capture, Storage, and Use: Technical, Economic, Environmental, and Societal Perspectives," edited by David Reiner

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**--**	**--**	**2**	**1**	**--**	**--**	**--**	**--**	**1**
CO4	**3**	**3**	**--**	**--**	**--**	**2**	**1**	**--**	**--**	**--**	**--**	**1**
CO5	**3**	**3**	**--**	**--**	**--**	**2**	**1**	**--**	**--**	**--**	**--**	**1**

High-3, Medium-2, Low-1

Semester: III		
MATLAB FOR CHEMICAL ENGINEERS		
Course Code:	**MVJ22CH363**	**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 MATLAB programming, enabling them to write basic scripts and perform fundamental operations in the MATLAB environment.	
2	Equip with data manipulation and visualization skills in MATLAB, allowing them to analyze and present chemical engineering data effectively.	

3	Familiarize with numerical techniques in MATLAB for solving chemical engineering problems, including optimization and root finding
4	Create and simulate mathematical models of chemical engineering processes using MATLAB, providing valuable insights into system behavior.
5	Apply MATLAB to various chemical engineering applications, including reaction kinetics, heat and mass transfer, process control, optimization, and introductory machine learning techniques.

MODULE-I	
Introduction to MATLAB: Introduction to MATLAB and its applications in chemical engineering; MATLAB environment, basic commands, and syntax; Variables, arrays, and matrices in MATLAB; MATLAB functions and scripts; Logical operations and control structures	**8 Hrs**
MODULE-II	
Data Handling and Visualization: Importing and exporting data in MATLAB; Data manipulation and preprocessing techniques; Plotting and customizing various types of graphs and charts; 2D and 3D visualization of chemical engineering data; Animating data and creating interactive visualizations	**8 Hrs**
MODULE-III	
Numerical Methods and Optimization: Solving algebraic equations and systems of equations; Root-finding and optimization techniques; Numerical integration and differentiation; Application of numerical methods to chemical engineering problems; MATLAB toolboxes for advanced numerical computing.	**8 Hrs**
MODULE-IV	
Simulations and Modeling: Developing mathematical models of chemical engineering processes; Simulation of chemical engineering systems using MATLAB; Solving ordinary differential equations (ODEs) and partial differential equations (PDEs); Model validation and sensitivity analysis; Introduction to Simulink for system-level simulations	**8 Hrs**
MODULE-V	
Applications in Chemical Engineering: MATLAB applications in reaction kinetics and reactor design; Heat and mass transfer simulations using MATLAB; MATLAB for process control and optimization; Introduction to machine learning with MATLAB in chemical engineering; Case studies and real-world projects in chemical engineering using MATLAB	**8 Hrs**

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

CO1	Write MATLAB scripts to solve simple chemical engineering problems, demonstrate an understanding of variables, arrays, and logical operations, and apply control structures in their scripts.
CO2	Proficient in importing and preprocessing data in MATLAB, creating various types of graphs and charts to visualize chemical engineering data, and producing interactive visualizations to communicate results
CO3	apply numerical methods to solve algebraic equations, implement optimization algorithms, perform numerical integration and differentiation, and utilize MATLAB toolboxes for advanced numerical computations in chemical engineering
CO4	Ability to develop mathematical models for chemical engineering systems, simulate dynamic processes using MATLAB, solve ODEs and PDEs relevant to chemical engineering, and conduct model validation and sensitivity analysis.
CO5	Gain hands-on experience in applying MATLAB to solve chemical engineering problems, such as simulating reaction kinetics and reactor designs, conducting heat and mass transfer simulations, implementing process control strategies, optimizing chemical processes, and exploring introductory machine learning concepts

Reference Books	
1.	MATLAB For Engineers, 6th Edition, Holly Moore, Pearson education
2.	Chemical Engineering Computation with MATLAB®. 2nd Edition, Yeong Koo Yeo, CRC Press
3.	"Numerical Methods for Chemical Engineering: Applications in MATLAB" by Kenneth J. Beers, Cambridge 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 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**--**	**--**	**2**	**--**	**--**	**1**
CO2	**3**	**3**	**2**	**--**	**2**	**--**	**--**	**--**	**2**	**--**	**--**	**1**
CO3	**3**	**3**	**2**	**--**	**2**	**--**	**--**	**--**	**2**	**--**	**--**	**1**
CO4	**3**	**3**	**2**	**1**	**2**	**--**	**--**	**--**	**2**	**--**	**--**	**1**
CO5	**3**	**3**	**2**	**1**	**2**	**--**	**--**	**--**	**2**	**--**	**--**	**1**

High-3, Medium-2, Low-1

Semester: III		
DATA SCIENCE FOR ENGINEERS		
Course Code:	**MVJ22CH364**	**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	Develop a foundational understanding of key data science concepts and principles applicable to engineering problems.	
2	Gain proficiency in using Python for data analysis, with a focus on Pandas, and apply these skills to manipulate and preprocess engineering datasets.	
3	Apply statistical concepts, hypothesis testing, and machine learning algorithms to analyze and model relationships within engineering datasets.	

UNIT-I	
Introduction to Data Science and Python Programming: Overview of data science and its applications in engineering; Introduction to Python programming for data analysis; Data types, variables, and basic data structures in Python	**8 Hrs**
UNIT-II	
Data Manipulation and Exploratory Data Analysis: Introduction to Pandas library for data manipulation, Handling data frames and series, Data cleaning and preprocessing techniques, Descriptive statistics and data visualization, Exploratory data analysis techniques, Case studies in EDA for engineering datasets	**8 Hrs**
UNIT-III	
Statistical Concepts and Machine Learning Basics: Probability and statistical distributions, Hypothesis testing and confidence intervals, Regression analysis for engineering applications, Introduction to machine learning, Supervised and unsupervised learning, Linear regression, classification, and clustering algorithms	**8 Hrs**
UNIT-IV	
Feature Engineering, Model Evaluation, and Big Data: Feature selection and extraction, Model evaluation metrics, Cross-validation and overfitting, Introduction to big data concepts, Basics of distributed computing and storage, Overview of data engineering tools and frameworks	**8 Hrs**
UNIT-V	
Application: Application of data science techniques to Chemical Engineering problems, Presentation of capstone projects.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Articulate the significance of data science in engineering,

CO2	clean, preprocess, and analyze engineering datasets and apply exploratory data analysis techniques.
CO3	Apply statistical concepts and regression analysis to model engineering relationships, and gain a foundational understanding of machine learning algorithms for data-driven decision-making.
CO4	Gain an awareness of big data concepts and tools relevant to engineering datasets
CO5	Demonstrate the practical application of data science techniques to solve a real-world Chemical Engineering problem.

Reference Books	
1.	“Data Science for Engineers" by John C. Zikopoulos
2.	"Introduction to Python for Engineers and Scientists" by Hans Fangohr

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 subdivisions. 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**	**--**	**--**	**--**	**2**	**--**	**--**	**1**

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

High-3, Medium-2, Low-1

Semester III			
SOCIAL CONNECT & RESPONSIBILITY			
Course Code:	**MVJ22SCR37**	**CIE Marks:**	**50**
Credits: L:T:P	**0:0:2**	**SEE Marks:**	**50**
Hours:	**26L**	**SEE Duration:**	**3 Hrs**

Course objectives: The course will enable the students to:

1. Provide a formal platform for students to communicate and connect to the surrounding.
2. Create a responsible connection with the society.
3. Understand the community in general in which they work.
4. Identify the needs and problems of the community and involve them in problem – solving.
5. Develop among them a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
6. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.

General Instructions - Pedagogy :

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied social and cultural skills.
2. State the need for activities and its present relevance in the society and Provide real-life examples.
3. Support and guide the students for self-planned activities.
4. You will also be responsible for assigning homework, grading assignments and quizzes and documenting students' progress in real activities in the field.
5. Encourage the students for group work to improve their creative and analytical skills.

Contents :

The course is mainly activity-based that will offer a set of activities for the student that enables them to connect with fellow human beings, nature, society, and the world at large. The course will engage students for interactive sessions, open mic, reading group, storytelling sessions, and semester-long activities conducted by faculty mentors.

In the following a set of activities planned for the course have been listed:

Social Connect & Responsibility – Contents

Part I:

Plantation and adoption of a tree:

Plantation of a tree that will be adopted for four years by a group of BE / B.Tech students. (ONE STUDENT ONE TREE) They will also make an excerpt either as a documentary or a photo blog describing the plant's origin, its usage in daily life, its appearance in folklore and literature - – Objectives, Visit, case study, report, outcomes.

Part II :

Heritage walk and crafts corner:

Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photo blog and documentary on evolution and practice of various craft forms - – Objectives, Visit, case study, report, outcomes.

Part III :

Organic farming and waste management:

Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus – Objectives,Visit, case study, report, outcomes.

Part IV:

Water conservation:

Knowing the present practices in the surrounding villages and implementation in the campus, documentary or photoblog presenting the current practices – Objectives, Visit, case study, report, outcomes.

Part V :

Food walk:

City's culinary practices, food lore, and indigenous materials of the region used in cooking – Objectives, Visit, case study, report, outcomes.

Course Outcomes: After completing the course, the students will be able to	
CO1	Communicate and connect to the surrounding.
CO2	Create a responsible connection with the society.
CO3	Involve in the community in general in which they work.
CO4	Notice the needs and problems of the community and involve them in problem – solving.
CO5	Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
CO6	Develop competence required for group-living and sharing of responsibilities & gain skills

Activities:

Jamming session, open mic, and poetry: Platform to connect to others. Share the stories with others. Share the experience of Social Connect. Exhibit the talent like playing instruments, singing, one-act play, art-painting, and fine art.

PEDAGOGY:

The pedagogy will include interactive lectures, inspiring guest talks, field visits, social immersion, and a course project. Applying and synthesizing information from these sources to define the social problem to address and take up the solution as the course project, with your group. Social immersion with NGOs/social sections will be a key part of the course. Will all lead to the course project that will address the needs of the social sector?

COURSE TOPICS:

The course will introduce social context and various players in the social space, and present approaches to discovering and understanding social needs. Social immersion and inspiring conversional will culminate in developing an actual, idea for problem-based intervention, based on an in-depth understanding of a key social problem.

Duration:

A total of 40 - 50 hrs engagement per semester is required for the 3rd semester of the B.E. /B.Tech. program. The students will be divided into groups. Each group will be handled by faculty mentor. Faculty mentor will design the activities (particularly Jamming sessions open mic ,and poetry) Faculty mentors has to design the evaluation system as per VTU guidelines of scheme & syllabus.

Guideline for Assessment Process:

Continuous Internal Evaluation (CIE):

After completion of the course, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learned in the social connect period. The report should be signed by the mentor. The report shal be evaluated on the basis of the following criteria and/or other relevant criteria pertaining to the activity completed. Marks allotted for the diary are out of 50. Planning and scheduling the social connect Information/Data collected during the social connect Analysis of the information/data and report writing Considering all above points allotting the marks as mentioned below

Excellent	: 80 to 100
Good	: 60 to 79
Satisfactory	: 40 to 59 Unsatisfactory and fail : <39

Special Note:

NO SEE – Semester End Exam –

Completely Practical and activities based evaluation

Pedagogy – Guidelines:

It may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution.

Sl No	Topic	Group size	Location	Activity execution	Reporting	Evaluation Of the Topic
1.	Plantation and adoption of a tree:	May be individual or team	Farmers land/ parks / Villages / roadside/ community area / College campus etc…..	Site selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
2.	Heritage walk and crafts corner:	May be individual or team	Temples / monumental places / Villages/ City Areas / Grama panchayat/ public associations/Governm e nt Schemes officers/ campus etc…..	Site selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
3.	Organic farming and waste management	May be individual or team	Farmers land / parks / Villages visits / roadside/ community area / College campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty

4.	Water conservation & conservation techniques	May be individual or team	Villages/ City Areas / Grama Panchayat/ public associations/ Government Schemes officers / campus etc…..	site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
5.	Food walk: Practices in society	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty

Plan of Action (Execution of Activities)

Sl.NO	Practice Session Description
1	Lecture session in field to start activities
2	Students Presentation on Ideas
3	Commencement of activity and its progress
4	Execution of Activity
5	Execution of Activity
6	Execution of Activity
7	Execution of Activity
8	Case study based Assessment, Individual performance
9	Sector/ Team wise study and its consolidation
10	Video based seminar for 10 minutes by each student At the end of semester with Report.

- Each student should do activities according to the scheme and syllabus.
- At the end of semester student performance has to be evaluated by the faculty for the assigned activity progress and its completion.
- At last consolidated report of all activities from 1st to 5th, compiled report should be submitted as per the instructions and scheme.

Assessment Details for CIE (both CIE and SEE)

Weightage	CIE – 100%	• Implementation strategies of the project (NSS work). • The last report should be signed by NSS Officer, the HOD and principal. • At last report should be evaluated by the NSS officer of the institute. • Finally the consolidated marks sheet should be sent to the university and also to be made available at LIC visit.
Field Visit, Plan, Discussion	10 Marks	
Commencement of activities and its progress	20 Marks	
Case study based Assessment Individual performance with report	20 Marks	
Sector wise study & its consolidation 5*5 = 25	25 Marks	
Video based seminar for 10 minutes by each student At the end of semester with Report. Activities 1 to 5, 5*5 = 25	25 Marks	
Total marks for the course in each semester	100 Marks	
For each activity, 20 marks CIE will be evaluated for IA marks at the end of semester, Report and assessment copy should be made available in the department.		
Students should present the progress of the activities as per the schedule in the prescribed practical session in the field. There should be positive progress in the vertical order for the benefit of society in general through activities.		

Semester: III		
Additional Mathematics-I (Common to all branches)		
Course Code:	**MVJ22MATDIP-i**	**CIE Marks:100**
Credits: L:T:P	**1:2:0**	**SEE Marks: 0**
Hours:	**30L**	
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 iintegral 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.	**8Hrs**
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.	**8Hrs**
UNIT-III	
Vector Differentiation: Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. **Vector identities**- $div(\phi \vec{A})$, $curl(\phi \vec{A})$, $curl(grad(\phi))$, $div(curl \vec{A})$.	**8Hrs**
UNIT-IV	
Probability: Basic terminology, Sample space and events. Axioms of probability. Conditional probability – illustrative examples. Bayes theorem-examples.	**8Hrs**
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.	**8Hrs**

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.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers 10thedition,2014.
3.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
4.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications 8th Edition.

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

Semester: IV		
CHEMICAL ENGINEERING THERMODYNAMICS (Theory)		
Course Code:	**MVJ22CH41**	**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 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.	

MODULE-I	
BASIC CONCEPTS: System, surrounding and processes, Closed and open systems, Intensive and extensive properties, 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.	**8 Hrs**
MODULE-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**

MODULE-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 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.	**8 Hrs**
MODULE-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**
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
UNIT PROCESS IN ORGANIC SYNTHESIS		
Course Code:	**MVJ22CH42**	**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		
Acquire a deep understanding of diverse chemical processes employed in industrial settings. Cultivate expertise in formulating and constructing process flow diagrams (PFDs) tailored to a range of industrial sectors.		

UNIT-I	
Introduction: Definition and importance of unit processes in chemical engineering, Concept of unit operation and unit processes and their role in systematizing the cognitive structure of chemical industries, Classification of unit processes, Chemical process kinetics and Factors affecting, Symbols used in Chemical Engineering, Process flow diagram.	8Hrs
UNIT-II	
Nitration: Introduction, Nitrating Agents, Aromatic Nitration –Theory of aromatic nitration, Kinetics & Mechanism of Aromatic Nitration	8Hrs
UNIT-III	
Amination: Amination by reduction introduction, definition, methods of reduction, Reaction mechanism, synthesis of aniline by reduction, catalytic hydrogenation-production of Hydrogen by amination.	8Hrs
UNIT-IV	
Halogenation: Introduction, Chlorination, Iodination, fluorination, chlorination of ethane, propane. Design & construction of Halogenations, Photo halogenations.	8Hrs
UNIT-V	
Hydrocarbon & Hydro formylation: Introduction, Fischer-Tropsch process, catalysts, thermodynamics of FisherTropsch processes, processes related to fisher Tropsch processes. Esterification: Introduction, Esterification of carboxylic acid derivatives, design & operation of esterification process.	8Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend the role and significance of unit processes in chemical industries, distinguishing between unit operations and unit processes.
CO2	Explain the mechanisms and kinetics of aromatic nitration reactions.
CO3	Analyze the principles of Amination.
CO4	Identify the types of halogenations reactions and evaluate their commercial significance.
CO5	Understand the principles of Hydrocarbon process, esterification and hydrolysis reactions, and their relevance in organic synthesis and chemical process equipment design.

Reference Books	
1.	Unit Processing of Organic Synthesis, 5th edition, Groggins P. H. Tata-McGraw Hill, New Delhi, 2001
2.	Organic Chemistry (7th Edition) by Paula Yurkanis Bruice, published by Pearson in 2014.

3.	Shreve's Chemical Process Industries, 5th Edition, Austin G. T, McGraw-Hill Pub., 1994.
4.	Dryden's Outlines of Chemical Tech. 2nd Ed, East-West Pub., New Delhi, 1997.

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

Semester: IV		
PROCESS HEAT TRANSFER (Theory and Practice)		
Course Code:	**MVJ22CH43**	**CIE Marks:50**
Credits: L:T:P	**2:2:2**	**SEE Marks: 50**
Hours:	**50 L+ 26L**	**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.

MODULE-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**
MODULE-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, Colburn, Prandtl analogies.	**8 Hrs**
MODULE-III	
Heat Transfer with Phase Change: heat transfer to fluids with phase change; heat transfer from condensing vapors, 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**
MODULE-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**
MODULE-V	
Heat Transfer Equipment: double pipe heat exchanger. Shell and tube heat exchangers, condensers, construction and working, types of shell and tube heat 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.	**8 Hrs**

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

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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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
UNIT PROCESS IN ORGANIC SYNTHESIS LAB		
Course Code:	**MVJ22CHL44**	**CIE Marks:50**
Credits: L: T: P	**0:0:2**	**SEE Marks: 50**
Hours:	**26P**	**SEE Duration: 03 Hours**
Course Learning Objectives: The students will be able to		
To Understand the practical aspects of organic synthesis reactions employed in chemical process industries		

LABORATORY EXPERIMENTS
1. Preparation of Benzoic acid from Toluene by KMnO4 2. Estimation of glycine 3. Preparation of P-Nitroacetanalide from acetanalide 4. Preparation of Aniline from Nitrobenzene 5. Estimation of Glucose by Iodometric method 6. Preparation of Hippuric acid 7. Preparation of Benzamide from Benzoyl chloride 8. Estimation of Phenol by bromination method 9. Chemical structure & reactions by using chem sketch / chem draw **(Can be Demo experiments for CIE)** 10. Synthesis of BaSO4 by gravimetric method **(Can be Demo experiments for CIE)** 11. Synthesis of ester by esterification **(Can be Demo experiments for CIE)**

Course Outcomes: After completing the course, the students will be able to	
CO1	Able to carry out nitration reactions, use nitrating agents calculate conversion yield
CO2	To carryout amination reaction, calculate % conversion and yield
CO3	Able to conduct chlorination reactions and report yield
CO4	Select sulphating agents carryout sulfonation and sulfation reactions
CO5	Design and operation of esterification

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.

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: IV		
INDUSTRIAL BIOTECHNOLOGY		
Course Code:	**MVJ22CH451**	**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 fundamental principles of industrial biotechnology and its applications in chemical engineering industries.	
2	Familiarize with the principles of microbial fermentation and its role in the production of bio-based products in industrial settings.	
3	Describe the engineering aspects of bioprocessing, including mass and energy balances, and the challenges of scale-up in industrial biotechnology.	
4	Understand about the separation, purification, and recovery of bio-based products from fermentation broth in industrial biotechnology	
5	Explore various industrial applications of biotechnology, including the production of biofuels, enzymes, pharmaceuticals, and other bio-based products.	

MODULE-I	
Introduction to Industrial Biotechnology: Overview of Biotechnology and its applications in Industries; Introduction to microbial bioprocessing and its significance in chemical engineering; Comparison of conventional chemical processes with bioprocessing; Overview of bioreactors and their types used in industrial biotechnology.	**8 Hrs**
MODULE-II	
Microbial Fermentation: Microorganisms and their role in bioprocessing: Fermentation processes and their applications in industry: Design and optimization of fermentation processes for bio-based products; Factors affecting microbial growth and product formation in fermentations.	**8 Hrs**
MODULE-III	
Bioprocess Engineering and Scale-Up: Engineering aspects of bioprocessing: mass and energy balances; Kinetics of microbial growth and product formation in bioreactors; Scale-up principles and challenges in industrial biotechnology; Bioreactor design and operation for large-scale production.	**8 Hrs**
MODULE-IV	
Downstream Processing and Product Recovery: Separation and purification of bio-based products from fermentation broth; Techniques for downstream processing, including filtration, chromatography, and centrifugation; Product	**8 Hrs**

recovery methods and their impact on process economics; Case studies on downstream processing in industrial biotechnology.	
MODULE-V	
Industrial Applications of Biotechnology: Production of biofuels, enzymes, pharmaceuticals, and biopolymers; Biotechnology in waste treatment and bioremediation processes; Biotechnology in the food and beverage industries.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the idea of industrial biotechnology and its significance in chemical engineering processes and industries.
CO2	Describe the fermentation processes used in industrial biotechnology and their applications in producing bio-based products.
CO3	Apply engineering principles to bioprocessing, including understanding mass and energy balances; and discuss the principles and challenges of scale-up in industrial biotechnology.
CO4	Explain various techniques used in downstream processing, including filtration, chromatography, and centrifugation, and evaluate their impact on product recovery in industrial biotechnology
CO5	Identify and discuss the use of biotechnology in different industries, such as biofuel production, pharmaceuticals, and waste treatment, and understand the current trends and future prospects of industrial biotechnology.

Reference Books	
1.	"Bioprocess Engineering Principles" by Pauline M. Doran, Academic Press
2.	Bioprocess Engineering: Basic Concepts, by Michael L. Shuler , Fikret Kargi , Pearson Publications
3.	Biotechnology for Beginners, Reinhard Renneberg, Academic 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 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
BIO FUELS		
Course Code:	**MVJ22CH452**	**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 concept of biofuels and their significance as sustainable alternatives to conventional fossil fuels	
2	familiarize with the different biomass feedstocks used in biofuel production and the considerations for sustainable feedstock selection	
3	Understand the key production processes for biodiesel, bioethanol, biogas, and emerging biofuels	
4	Explore the chemical and enzymatic conversion technologies employed in biofuel production and their optimization	
5	Describe the environmental impact and economic aspects of biofuel production and usage.	

MODULE-I	
Introduction to Biofuels: Introduction to biofuels and their significance as renewable energy sources; Types of biofuels: biodiesel, bioethanol, biogas, and others; Comparison of biofuels with fossil fuels in terms of environmental impact and sustainability; Government policies and initiatives promoting biofuel adoption.	**8 Hrs**
MODULE-II	
Biomass Feedstocks for Biofuel Production: Overview of biomass sources for biofuel production (e.g., agricultural residues, energy crops, algae); Feedstock selection criteria and considerations for sustainable feedstock supply; Pre-treatment and handling of biomass for efficient biofuel conversion; Life cycle analysis and carbon footprint assessment of different feedstocks.	**8 Hrs**
MODULE-III	
Biofuel Production Processes: Biodiesel production through the transesterification of vegetable oils and animal fats; Bioethanol production through fermentation of sugars and lignocellulosic biomass; Biogas production through anaerobic digestion of organic matter; Emerging technologies for advanced biofuels (e.g., bio-syngas, bio-hydrogen).	**8 Hrs**
MODULE-IV	

Biofuel Conversion Technologies: Chemical and enzymatic conversion processes for biofuel production; Process engineering and optimization of biofuel conversion reactors; Co-products and by-products in biofuel production and their utilization; Techno-economic analysis of biofuel production processes	**8 Hrs**
MODULE-V	
Environmental and Economic Aspects of Biofuels: Environmental impacts of biofuel production and use: greenhouse gas emissions, land use, and water consumption; Sustainability considerations and challenges in large-scale biofuel implementation; Economic viability and market potential of biofuels compared to conventional fossil fuels; Integration of biofuels in existing energy infrastructure and future energy scenarios.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the various types of biofuels, understand their environmental impact, and recognize their potential as renewable energy sources.
CO2	Identify various biomass sources suitable for biofuel production, evaluate their sustainability, and understand the pre-treatment requirements for efficient conversion.
CO3	Describe the processes involved in biodiesel, bioethanol, and biogas production, and appreciate the potential of emerging biofuels like bio-syngas and bio-hydrogen
CO4	Understand the chemical and enzymatic conversion processes used in biofuel production, analyze reactor design considerations, and identify potential co-products and by-products.
CO5	Evaluate the environmental impacts of biofuels, discuss sustainability challenges, and analyze the economic viability and market potential of biofuels in comparison to conventional fossil fuels.

Reference Books	
1.	"Bioprocess Engineering Principles" by Pauline M. Doran, Academic Press
2.	Bioprocess Engineering: Basic Concepts, by Michael L. Shuler , Fikret Kargi , Pearson Publications
3.	Biotechnology for Beginners, Reinhard Renneberg, Academic 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 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
COMPUTATIONAL FLUID DYNAMICS (Theory)		
Course Code:	**MVJ22CH453**	**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.	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**

MODULE-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

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
INTRODUCTION TO R LANGUAGE (Theory)		
Course Code:	**MVJ22CH454**	**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 the basics of R Language and its fundamental components	
2	learn about statistical data analysis and building interactive applications	

MODULE-I	
Introduction: R interpreter, Introduction to major R data structures like vectors, matrices, arrays, list and data frames, Control Structures, vectorized if and multiple selection, functions.	**8 Hrs**
MODULE-II	
Installing, loading and using packages: Read/write data from/in files, extracting data from web-sites, Clean data, Transform data by sorting, adding/removing new/existing columns, centring, scaling and normalizing the data values, converting types of values, using string in-built functions.	**8 Hrs**
MODULE-III	
Statistical analysis of data for summarizing and understanding data, Visualizing data using scatter plot, line plot, bar chart, histogram and box plot.	**8 Hrs**
MODULE-IV	
Designing GUI: Building interactive application and connecting it with data base.	**8 Hrs**
MODULE-V	
Building Packages.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Learn about the essential components of R Language
CO2	Understand about installing, loading and using packages.
CO3	Learn about statistical analysis of data using packages.
CO4	Understand the visualization of data using scatter plot, line plot, tools, etc.,
CO5	Build interactive application and connecting with database

Reference Books	
1.	R for Data Science by Hadley Wickham and Garrett Grolemund

2.	The Book of R by Tilman M. Davies
3.	Discovering Statistics using R by Andy Field, Jeremy Miles, and Zoe Field.
4.	The Art of R Programming by Jared P. Lander

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**2**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
BIOLOGY FOR ENGINEERS		
Course Code:	**MVJ22BI47**	**CIE Marks:50**
Credits: L:T:P:	**2:0:0**	**SEE Marks: 50**
Hours:	**30L**	**SEE Duration: 2 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the basic principles of biology and their significance in engineering.	
2	Gain Knowledge on the processes of cell division and the cell cycle.	
3	Assess the applications of microorganisms in biotechnology by evaluating their roles and contributions in various engineering contexts.	
4	Analyze the principles of tissue engineering and regenerative medicine by synthesizing and integrating key concepts to explain their significance in biomedical engineering.	
5	Describe the processes and techniques used in water and wastewater treatment.	

UNIT-I	
Introduction to Biology and Biomolecules: Introduction to biology and its relevance to engineering; Structure and function of biomolecules (proteins, carbohydrates, lipids, nucleic acids); Protein structure and function; Enzymes and their role in biological systems; Metabolism and energy in living organisms	**8 Hrs**
UNIT-II	
Cell Biology and Genetics: Introduction to cell biology and the structure of cells; Cell membrane structure and function; Cellular organelles and their roles; Cell division and the cell cycle; Introduction to Genetics and Inheritance; DNA structure and replication; Transcription and translation; Genetic engineering and biotechnology	**8 Hrs**
UNIT-III	
Microbiology and Biotechnology: Introduction to microbiology and microbial diversity; Bacteria, viruses, fungi, and other microorganisms; Microbial growth and control; Applications of microorganisms in biotechnology; Bioreactors and fermentation processes; Industrial microbiology and microbial products	**8 Hrs**
UNIT-IV	
Biomedical Engineering and Tissue Engineering: Introduction to biomedical engineering; Biomechanics and biomaterials; Medical imaging and diagnostic techniques; Introduction to tissue engineering and regenerative medicine; Biomaterial scaffolds and their design; Cell and tissue culture techniques; Applications of tissue engineering in medicine	**8 Hrs**
UNIT-V	
Environmental and Ecological Engineering: Introduction to environmental engineering; Water and wastewater treatment; Air pollution and control measures; Environmental monitoring and assessment; Introduction to ecology and ecosystems; Conservation biology and sustainable practices; Bioremediation and environmental biotechnology	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the basic principles of biology to engineering contexts
CO2	Demonstrate knowledge of the processes of cell division and the cell cycle
CO3	Evaluate and assess the applications of microorganisms in biotechnology
CO4	Analyze and synthesize the principles of tissue engineering and regenerative medicine
CO5	Describe the processes and techniques used in water and wastewater treatment

Reference Books	
1.	"Biology for Engineers" by Singal R, CBS Publishers
2.	"Biology for Engineers" by Wiley Editorial, Wiley Publishers

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 subdivisions. 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**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO2	**3**	**2**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO3	**3**	**2**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**2**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

CO5	**3**	**2**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: IV		
UNIVERSAL HUMAN VALUES (Theory)		
Course Code:	**MVJ22UHV48**	**CIE Marks: 50**
Credits: L:T:P:	**1:0:0**	**SEE Marks: 50**
Hours:	**15 L**	**SEE Duration: 01 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. Video link: • https://www.youtube.com/watch?v=85XCw8SU084 • https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA 3p Z3yA7g_OAQz • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**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 Video link: • https://www.youtube.com/watch?v=GpuZo495F24 • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**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 Video link: • https://www.youtube.com/watch?v=F2KVW4WNnS • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**6 Hrs**
UNIT-IV	
Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders 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 Video link: • https://www.youtube.com/watch?v=1HR-QB2mCF0 • https://www.youtube.com/watch?v=lfN8q0xUSpw • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**6 Hrs**
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 Video link: • https://www.youtube.com/watch?v=BikdYub6RY0 • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	**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):

CIE for 50 marks 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):

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.

Total marks: 50+50=100

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

Semester: IV		
Additional Mathematics-II **(Common to all branches)**		
Course Code:	**MVJ22MATDIP-II**	**CIE Marks:100**
Credits: L:T:P	**1:2:0**	**SEE Marks: 00**
Hours:	**30L**	
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.	**8 Hrs**
UNIT-II	
Differentialcalculus: 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.	**8Hrs**
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.	**8Hrs**
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.	**8 Hrs**
UNIT-V	
Partial differential equation: Introduction- Classification of partial differential equations, formation of partial differential equations. Method of elimination of arbitrary constants and functions. Solutions of non-homogeneous partial differential equations by direct integration. Solution of Lagrange's linear PDE.	**8 Hrs**

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 eigen values and eigenvectors 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	
3.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
4.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers 10thedition,2014.
3.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
4.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications 8th Edition.

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

Semester: V		
Industrial Process Management (Theory)		
Course Code:	**MVJ22CH51**	**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.	

MODULE-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**
MODULE-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**
MODULE-III	
Social Responsibilities of Business: Meaning of Social Responsibility, Social	**8 Hrs**

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, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.	
MODULE-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**
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**1**	**2**					**1**	**--**	**2**	**1**
CO2	**1**	**2**	**1**	**2**					**1**	**--**	**2**	**1**
CO3	**1**	**2**	**1**	**2**					**1**	**--**	**2**	**1**
CO4	**1**	**2**	**1**	**1**					**1**	**--**	**2**	**1**
CO5	**1**	**2**	**1**	**2**					**1**	**--**	**2**	**1**

High-3, Medium-2, Low-1

Semester: V		
CHEMICAL REACTION ENGINEERING (Theory)		
Course Code:	**MVJ22CH52**	**CIE Marks:50**
Credits: L:T:P	**3:2:0**	**SEE Marks: 50**
Hours:	**50L**	**SEE Duration: 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.	

MODULE-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, Testing of mechanisms of kinetic study, interpretation of kinetic data.	**8 Hrs**
MODULE-II	
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. **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**
MODULE-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**
MODULE-IV	
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**

MODULE-V	
Catalysis: introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, Inhibitors etc, mechanism of catalysis. Rate equations for different rate controlling step. **Deactivation:** deactivating catalyst.	**8 Hrs**

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.

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE having same complexity in terms of COs and Bloom's taxonomy level.

Semester: V		
MASS TRANSFER – I **(Theory)**		
Course Code:	**MVJ22CH53**	**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	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	

MODULE-I	
Diffusion: 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**
MODULE-II	
Humidification: general theory, psychometric chart. Adiabatic saturation temperature, wet bulb temperature, concepts in humidification dehumidification. Cooling tower calculations.	**8 Hrs**
MODULE-III	
Drying: Introduction, equilibrium, drying rate curves. Mechanism of drying, types of dryers. Drying time calculations, Design of batch and continuous dryers.	**8 Hrs**
MODULE-IV	
Adsorption: Theories of adsorption. Isotherms, industrial adsorbents. equipment, batch and continuous multistage adsorption, Adsorption calculations-single stage, multi stage cross current, counter current operations, Application of Freundlich equation	**8 Hrs**
MODULE-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 behaviour 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 crystallisation in design of crystalliser 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**--**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**2**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**2**	**-**	**-**	**-**		**-**	**-**	**-**	**-**	**-**

High-3, Medium-2, Low-1

Semester: V		
CHEMICAL REACTION ENGINEERING LAB		
Course Code:	**MVJ22CHL54**	**CIE Marks:50**
Credits: L:T:P	**0:0:2**	**SEE Marks: 50**
Hours:	**26 P**	**SEE Duration: 03 Hours**
Course Learning Objectives: The students will be able to		
1	To familiarize students with essential experimental techniques used in chemical reaction engineering, such as reactor operation and monitoring	
2	Equip with the practical skills and knowledge necessary to understand, analyze, and design chemical reactions and reactors effectively	

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	Demonstrate Competence in Experimental Techniques: to proficiently perform chemical reaction experiments in the laboratory, including setting up reactors, monitoring reaction progress, and collecting accurate and reliable data.
CO2	Analyze Reaction Kinetics and Rate Data: capable of analyzing experimental data to determine reaction kinetics, rate constants, and reaction mechanisms, enabling them to understand the fundamental principles of chemical reaction engineering.
CO3	Design and Optimize Chemical Reactors: to design and optimize chemical reactors for specific reactions, considering factors such as reactor type, residence time, and temperature to achieve desired reaction outcomes.
CO4	Apply Safety Protocols and Hazard Handling: prioritize safety in the laboratory setting

	by adhering to proper safety protocols, handling hazardous materials responsibly, and mitigating potential risks associated with chemical reactions.
CO5	Communicate Experimental Findings Effectively: develop strong communication skills by presenting their experimental findings, data analyses, and interpretations in clear and concise written reports and oral presentations.

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.

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

High-3, Medium-2, Low-1

Semester: V		
CHEMICAL PROCESS INDUSTRIES (Theory)		
Course Code:	**MVJ22CH551**	**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.	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**

MODULE-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

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: V		
PIPING ENGINEERING (Theory)		
Course Code:	**MVJ22CH552**	**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 role and responsibilities of a piping engineer and the significance of piping engineering in various industries	
2	Design piping systems, perform hydraulic calculations, and layout piping routes efficiently within a plant	
3	Develop material specifications, select appropriate piping materials, and understand fabrication techniques used in piping construction.	
4	Gain knowledge of safe and effective piping installation practices, including pre-commissioning checks and pressure testing procedures.	
5	Develop maintenance strategies, identify and mitigate piping system hazards, and implement safety protocols in piping operations	

MODULE-I	
Introduction to Piping Engineering: Overview of Piping Engineering: Role, significance, and responsibilities of a piping engineer in various industries; Piping Codes and Standards: An Introduction to International Codes and Standards Governing the Design, Fabrication, and Installation of Pipe Systems; Piping Materials: Study of different piping materials, their properties, and selection criteria for specific applications; Piping Components: Detailed examination of various piping components, such as fittings, valves, flanges, and supports	**8 Hrs**
MODULE-II	
Piping System Design and Layout: Piping System Design Basics: Understanding flow rates, pressure drops, and hydraulic calculations for designing piping systems; Piping Layout and Routing: Principles of Layout Planning, Equipment Arrangement, and Routing of Piping Systems Within a Plant; Isometric Drawings and Piping Symbols: Interpretation of Isometric Drawings and Standard Piping Symbols Used in Engineering Drawings; Pipe Stress Analysis: An Introduction to Pipe Stress Analysis to Ensure the Safety and Integrity of Pipe Systems Under Various Operating Conditions	**8 Hrs**
MODULE-III	
Piping Material Specifications and Fabrication: Piping Material Specifications: Developing material specifications based on design requirements and industry	**8 Hrs**

standards; Piping Fabrication Techniques: An Overview of Fabrication Methods, including Welding, Bending, and Joining of Pipe Materials; Non-Destructive Testing (NDT) Techniques: An Introduction to NDT Techniques for Inspecting Welds and Detecting Flaws in Pipelines; Quality Control and Inspection: Implementation of quality control procedures during piping fabrication to ensure compliance with standards.	
MODULE-IV	
Piping Installation and Commissioning: Piping Erection and Installation: Guidelines for Safe and Efficient Pipe Installation Practices, including Pre-Commissioning Checks; Pipe Cleaning and Flushing: Procedures for Cleaning and Flushing of Pipe Systems to Remove Debris and Contaminants Before Commissioning; Piping Testing and Commissioning: Conducting pressure tests and leak testing of piping systems before commissioning; Piping System Start-Up: Steps involved in the commissioning and start-up of piping systems, including safety measures and troubleshooting	**8 Hrs**
MODULE-V	
Piping Maintenance and Safety: Piping Maintenance Practices: Routine maintenance and inspection strategies to ensure the reliability and longevity of piping systems. Corrosion and Corrosion Protection: Understanding corrosion mechanisms and methods for corrosion protection in piping systems; Piping Safety Practices: Identification and mitigation of potential hazards in piping systems, including safety protocols and emergency procedures; Environmental Considerations: Environmental impacts of piping operations and methods for minimizing environmental footprints	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Demonstrate an understanding of the role and importance of piping engineering in various industries and its impact on overall plant operations.
CO2	Design and analyze piping systems, considering flow rates, pressure drops, and layout principles, to meet specific process requirements.
CO3	Select appropriate piping materials based on design specifications and understand various fabrication techniques used in piping construction.
CO4	Acquire the skills to safely and efficiently install piping systems, conduct pre-commissioning checks, and perform pressure testing to ensure system integrity.
CO5	Knowledge and awareness of maintenance practices, corrosion protection methods, and safety protocols required for the proper functioning and longevity of piping systems.

Reference Books	
1.	Introduction to Process Engineering and Design" by Thakore and Bhatt, McGrawhHill Publishers
2.	Piping Handbook by Mohinder Nayyar, McGrawhHill Publishers
3.	Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair by George A. Antaki
4.	Process Piping: The Complete Guide to ASME B31.3, Third edition by IV Becht, Charles

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
PETROLEUM REFINING & PETROCHEMICALS (Theory)		
Course Code:	**MVJ22CH553**	**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	Gain a comprehensive understanding of the various processes involved in petroleum refining, including crude oil separation, distillation, conversion, and treatment.	
2	Analyze the Petrochemical Production, the key reactions and processes involved.	
3	Evaluate and compare different refining and petrochemical technologies to determine their advantages, limitations, and environmental impacts.	
4	Understand the role of catalysts in refining and petrochemical processes and learn how to optimize these processes for maximum efficiency and yield.	
5	Examine the environmental and economic implications of petroleum refining and petrochemical production, including energy consumption, greenhouse gas emissions, and economic viability.	

MODULE-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**
MODULE-II	
Catalyst reforming: Catalytic reforming, polymerization, Isomerization, hydrogenation, production of aviation gasoline, motor fuel, kerosene, diesel oil and jet fuel.	**8 Hrs**
MODULE-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**
MODULE-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	**8 Hrs**

aromatics (benzene, xylene and toluene), aromatic conversion processes (depropanization, isomerisation, dealkylation).	
MODULE-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.
5	Austin G.T, Shreves Chemical Process industries

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO4	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
CO5	**3**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

High-3, Medium-2, Low-1

Semester: V		
Principles of Downstream Techniques in Bio process (Theory)		
Course Code:	**MVJ22CH554**	**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 principles and significance of downstream techniques in bioprocessing, and identify the key stages involved in bioprocess engineering.	
2	Describe and differentiate various separation techniques used in bioprocessing, such as centrifugation, filtration, and chromatography.	
3	Compare and contrast different cell disruption techniques and extraction methods for releasing intracellular products.	
4	Analyze and design processes for product purification and refining, including precipitation, crystallization, and refining methods.	
5	Describe the formulation techniques and final product processing steps essential for ensuring product stability and safety.	

MODULE-I	
Introduction to Downstream Techniques in Bioprocess: Overview of Bioprocess Engineering: An Introduction to the Principles and Applications of Bioprocess Technology in Chemical Engineering. Downstream Processing: Understanding the significance of downstream techniques in the purification and recovery of bio-products. Bioprocessing Steps: Examination of the Different Stages in Bioprocessing, including Upstream and Downstream Operations	**8 Hrs**
MODULE-II	
Separation Techniques in Bioprocessing Centrifugation: Principles and Applications of Centrifugation for Cell Separation and Bioproduct Recovery Filtration: Understanding various filtration techniques, such as microfiltration and ultrafiltration, in bioprocessing Chromatography: An Introduction to Chromatographic Methods for the Purification and Separation of Biomolecules.	**8 Hrs**
MODULE-III	
Cell Disruption Techniques: Study of mechanical, chemical, and enzymatic methods for cell disruption to release intracellular products	**8 Hrs**

Liquid-Liquid Extraction: Principles and Applications of Liquid-Liquid Extraction in Separating Valuable Compounds from Fermentation Broth Solid-Liquid Extraction: An Introduction to Solid-Liquid Extraction Methods, including Maceration and Percolation, in Bioprocesses	
MODULE-IV	
Product Purification and Refining Precipitation: Understanding the use of precipitation techniques to purify and concentrate bioproducts Crystallization: Principles of Crystallization for the Purification and Isolation of Biologically Derived Compounds Refining Techniques: An Introduction to Refining Methods, such as Distillation and Solvent Extraction, for Product Purification	**8 Hrs**
MODULE-V	
Formulation and Final Product Processing Product Formulation: Principles of Product Formulation, including Stabilization, Preservation, and Dosage Preparation Final Product Processing: Study of final processing steps, including sterilization and aseptic packaging, to ensure product safety and stability Quality Control and Regulatory Compliance: An Overview of Quality Control Measures and Regulatory Requirements in Downstream Bioprocessing	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehensive understanding of the role of downstream techniques in bioprocessing and their application in the purification and recovery of bioproducts.
CO2	Acquire the knowledge and skills to select appropriate separation techniques for specific bioprocessing tasks and understand their advantages and limitations.
CO3	Demonstrate the ability to apply suitable cell disruption and extraction techniques to efficiently recover target biomolecules from cells and fermentation broth.
CO4	Implementing effective product purification and refining strategies to obtain high-purity bioproducts and improve overall process yield
CO5	Develop the skills to formulate bioproducts, apply final processing techniques, and adhere to quality control measures and regulatory requirements in bioprocessing.

Reference Books	
1.	Principles of Downstream Techniques in Biological and Chemical Processes Mukesh Doble CRC press

2.	Ladisch, M.R., (2001), Bioseparation Engineering: Principles, Practice and Economics, Wiley, Interscience.

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	--	--	--	--	--	--	--	--	--	--
CO4	**3**	**3**	--	--	--	--	--	--	--	--	--	--
CO5	**3**	**3**	--	--	--	--	--	--	--	--	--	--

High-3, Medium-2, Low-1

Semester: V		
MINI PROJECT		
Course Code:	**MVJ22CHP56**	**CIE Marks: 50**
Credits: L:T:P:	**0:0:4**	**SEE Marks: 50**
Hours:	**15 L**	**SEE Duration: 3 Hrs.**

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.

MINI PROJECT: 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

Semester: V		
RESEARCH METHODOLOGY & IPR		
Course Code:	**MVJ22RMI57**	**CIE Marks: 50**
Credits: L:T:P:	**2:2:0**	**SEE Marks: 50**
Hours:	**20L+20P**	**SEE Duration: 3 Hrs.**
Course Learning Objectives: The students will be able to		
1	Identify an appropriate research problem in their interesting domain	
2	Understand ethical issues understand the preparation of a research project thesis report	
3	Understand the Preparation of a research project thesis report	
4	Understand the law of patent and copyrights	
5	Understand the Adequate knowledge on IPR	

MODULE-I	
Meaning of research problem: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	**6 Hrs**
MODULE-II	
Literature studies: Effective literature studies approaches, Meaning of Research Design, Need for Research Design, Features of a Good Design and analysis, Plagiarism, Research ethics	**6 Hrs**
MODULE-III	
Technical writing: Effective technical writing, how to write report, Paper Developing a Research Proposal. Format of research proposal, a presentation and assessment by a review committee.	**6 Hrs**
MODULE-IV	
Research proposal: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**6 Hrs**
MODULE-V	
Patent rights and new developments in IPR: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent	**6 Hrs**

System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the research problem and research process
CO2	Understand research ethics
CO3	Prepare a well-structured research paper and scientific presentations
CO4	Explore on various IPR components and process of filing
CO5	Understand the adequate knowledge on patent and rights

Reference Books	
1.	Research Methodology, Kothari, C.R,Gaurav Garg, 2018New Age International
2.	Research Methodology a step-by- step guide for beginners,Ranjit Kumar, 2011) (3rded.). SAGE Publications Ltd
3.	Research Methods: the concise knowledge base, Trochim. (2005). Atomic Dog Publishing
4.	Conducting Research Literature Reviews: From the Internet to Paper, Fink A. (2009). Sage 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum

of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VI		
CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING (Theory and Practice)		
Course Code:	**MVJ22CH61**	**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.	

MODULE-I	
Introduction: chemical engineering plant design, general overall design considerations, cost estimation; 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.	**8 Hrs**
MODULE-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.	**8 Hrs**
MODULE-III	
Material Transfer, handling and treatment equipment -design and costs. Heat transfer equipment design and costs. Mass transfer equipment design and costs.	**8 Hrs**
MODULE-IV	
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**
MODULE-V	
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**

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.	MODULE 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

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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)		
Course Code:	**MVJ22CH62**	**CIE Marks:50**
Credits: L:T:P	**2:2:0**	**SEE Marks: 50**
Hours:	**50 L**	**SEE Duration: 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.	

MODULE-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**
MODULE-II	
Packed Tower Absorption: Liquid phase hold up and pressure drop in absorption towers. Design of packed towers (process design-height of the absorber). **Distillation**: Introduction. Vapor liquid equilibrium (T-x,y, P-x,y. H-x,y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapor pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Flash and simple distillation.	**8 Hrs**
MODULE-III	
Distillation (Contd.): Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorel methods for binary mixtures. Ponchon- Savarit method. Introduction to Multi component distillation, Vacuum, molecular, extractive and azeotropic distillations.	**8 Hrs**
MODULE-IV	
Liquid-Liquid Extraction: Ternary liquid-liquid equilibrium. Solvent selection. Single stage and multi-stage cross-current, counter-current extraction. Extraction calculations- quantity and composition of extract and raffinate, number of stages required. Equipment for liquid-liquid extraction.	**8 Hrs**
MODULE-V	
Leaching Operation: Equipment for leaching. Phase diagrams, Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching operation.	**8 Hrs**

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 binary mixtures to calculate no of trays in multi-stage rectification column.
CO5	Develop the material balance equations 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

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.

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

High-3, Medium-2, Low-1

Semester VI		
MASS TRANSFER OPERATIONS LAB		
Course Code:	**MVJ22CHL63**	**CIE Marks:50**
Credits: L:T:P:	**0:0:2**	**SEE Marks: 50**
Hours:	**26P**	**SEE Duration: 03 Hours**
Course Learning Objectives: The students will be able to		
1	Apply theoretical knowledge gained from classroom instruction to real-world scenarios and practical experiments.	
2	Learn to measure critical parameters, collect experimental data accurately, and analyze the results.	

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 Vapor 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
Any 12 experiments to be conducted

Course Outcomes: After completing the course, the students will be able to	
CO1	Demonstrate proficiency in setting up and operating laboratory equipment used in mass transfer processes, including distillation columns, absorption units, and extraction equipment.
CO2	Gather experimental data systematically, apply appropriate statistical and computational techniques to analyze the data, and draw meaningful conclusions from the results.
CO3	Independently plan, execute, and troubleshoot mass transfer experiments, including distillation, absorption, extraction, and adsorption, to obtain reliable results.
CO4	Prepare detailed and accurate laboratory reports, including experimental setups, procedures, data tables, results, discussions, and conclusions.

CO5	Develop the ability to identify and address challenges and issues that may arise during experiments, demonstrating problem-solving skills in a laboratory context.

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.

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: VI		
NANOSCIENCE & NANOTECHNOLOGY (Theory)		
Course Code:	**MVJ22CH641**	**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.	

MODULE-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**
MODULE-II	
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	**8 Hrs**
MODULE-III	
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**
MODULE-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 Deposition (PVD), Molecular Beam Epitaxy (MBE). Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), Self-Assembly.	**8 Hrs**
MODULE-V	
Application of Nanotechnology: Environment: remediation and mitigation using metal oxide nano particles, magnetic particles, Nanomembranes and nanofilters,	**8 Hrs**

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.	

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

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO2	**3**	**2**	**1**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO3	**3**	**2**	**1**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO4	**3**	**2**	**1**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**
CO5	**3**	**3**	**1**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**1**

High-3, Medium-2, Low-1

Semester: VI		
PHARMACEUTICAL TECHNOLOGY (Theory)		
Course Code: MVJ22CH642		**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	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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	**8 Hrs**

of any pharmaceuticals/ capsules/pellets/cosmetics.	

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 Marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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**	**2**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

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

High-3, Medium-2, Low-1

Semester: VI		
FOOD TECHNOLOGY (Theory)		
Course Code:	**MVJ22CH643**	**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 MODULE 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.	

MODULE-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**
MODULE-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. MODULE 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**
MODULE-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**
MODULE-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.	
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
HETEROGENEOUS REACTION SYSTEMS (Theory)		
Course Code:	**MVJ22CH644**	**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.		

MODULE-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,	**8 Hrs**
MODULE-II	
Introduction to catalysis and heterogeneous reactions: catalyst drying calcinations and formulations, catalyst characterization techniques, structural analysis, chemisorptions technique, thermal analysis, spectroscopic techniques, microscopic technique.	**8 Hrs**
MODULE-III	
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, fluidized bed reactor, berty reactor, multiphase reactors- slurry reactor, trickle bed reactor, bioreactors, catalysts tests.	**8 Hrs**
MODULE-IV	
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 intra-pellet mass transfer on activation energy.	**8 Hrs**
MODULE-V	
Catalyst deactivation: types of catalyst deactivation, the kinetics of catalyst poisoning, kinetics of catalyst deactivation by coke formation. **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 catalyzed 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VI		
INDUSTRIAL POLLUTION & CONTROL (Theory)		
Course Code:	**MVJ22CH651**	**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.	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum

of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VI		
RENEWABLE ENERGY: RESOURCES AND TECHNOLOGIES (Theory)		
Course Code:	**MVJ22CH653**	**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.	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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.	
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
SOLID WASTE MANAGEMENT (Theory)		
Course Code:	**MVJ22CH654**	**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.	

MODULE-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**
MODULE-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**
MODULE-III	
Processing techniques: Mechanical volume reduction, Thermal volume reduction, Component separation, Land filling and land forming, Deep well injection.	**8 Hrs**
MODULE-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**
MODULE-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 –	**8 Hrs**

coal fired power stations, textile industry, oil refinery, distillery, sugar industry, radioactive and e-waste generation MODULEs.	

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum

of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VI		
PROJECT PHASE – I		
Course Code:	**MVJ22CHP66**	**CIE Marks:50**
Credits: L:T:P:	**0 : 0 : 4**	**SEE Marks: 50**
Hours:	**40**	**SEE Duration: 3 Hrs**

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 - I: 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

Semester: VII		
CHEMICAL PROCESS MODELLING AND SIMULATION (Theory and Practice)		
Course Code:	**MVJ22CH71**	**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.

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
PROCESS CONTROL & IIOT (Theory and Practice)		
Course Code: MVJ22CH72		**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	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.	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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, Smart Factories.	**8 Hrs**

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VII		
APPLIED MATHEMATICS IN CHEMICAL ENGINEERING (Theory)		
Course Code:	**MVJ22CH73**	**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	Apply mathematical techniques to solve chemical engineering problems.	
2	Analyze and model chemical engineering processes using mathematical equations.	
3	Understand the importance of mathematical tools in optimizing and designing chemical processes.	
4	Interpret and communicate mathematical results effectively in a chemical engineering context.	
5	Use software tools for numerical analysis and simulations in chemical engineering applications.	

MODULE-I	
Differential Equations in Chemical Engineering • Ordinary differential equations (ODEs) and their applications in chemical processes • First-order ODEs and their solutions • Higher-order ODEs and initial value problems • Boundary value problems (BVPs) and their relevance in chemical engineering	**10 Hrs**
MODULE-II	
Linear Algebra for Chemical Engineering • Matrices and matrix operations • Systems of linear equations • Eigenvalues and eigenvectors • Matrix transformations and their applications in chemical engineering	**10 Hrs**
MODULE-III	
Numerical Methods for Chemical Engineers • Root-finding methods (Newton-Raphson, bisection.) • Interpolation and curve fitting • Numerical integration and differentiation • Solving differential equations numerically	**10 Hrs**
MODULE-IV	
Optimization Techniques in Chemical Engineering • Introduction to optimization problems in chemical engineering • Linear programming and its applications • Nonlinear programming and gradient-based methods • Optimization under constraints and sensitivity analysis	**10 Hrs**

MODULE-V	
Statistical Analysis in Chemical Engineering • Basics of probability and statistics • Data analysis and visualization • Probability distributions and their applications • Statistical inference and hypothesis testing in chemical engineering experiments	**10 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply Mathematical Techniques to solve complex chemical engineering problems effectively.
CO2	Develop mathematical models for chemical engineering processes, showcasing an ability to translate real-world engineering scenarios into mathematical equations, enabling predictive analysis and optimization.
CO3	Apply numerical methods for root-finding, interpolation, numerical integration, and solving differential equations to address practical challenges encountered in chemical engineering applications.
CO4	Understand and implement optimization techniques, including linear and nonlinear programming, for the efficient design and operation of chemical processes under various constraints, leading to improved resource utilization.
CO5	Employ statistical tools and techniques to analyze experimental data, make data-driven decisions, and draw meaningful conclusions to enhance the quality of chemical engineering experiments and processes.

Reference Books	
1.	"Applied Mathematics for Chemical Engineers" by Louis Theodore and J. S. Vrentas
2.	"Numerical Methods for Engineers" by Steven C. Chapra and Raymond P. Canale
3.	"Linear Algebra and Its Applications" by Gilbert Strang
4.	"Introduction to Probability and Statistics for Engineers and Scientists" by Sheldon M. Ross

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VII		
TRANSPORT PHENOMENA (Theory)		
Course Code:	**MVJ22CH741**	**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	To introduce the students about basic laws of momentum, heat and mass transfer.	
2	To determine the heat transfer rate and temperature distribution for different heat transfer situations.	
3	To determine the mass transfer rate and concentration distribution for different mass transfer situations.	
4	To study the different analogies between mass, momentum and mass transfer.	
5	To study the different transport process analogies of the fluid.	

MODULE-I	
Introduction: Momentum energy and mass transport newton's law of viscosity. Newtonian and non-newtonian fluids. Fourier's law of heat conduction, fick's law of diffusion, effect of temperature and pressure on transport properties of fluids. numerical problems on the application and use of NLV, FLHC and FLD.	**10 Hrs**
MODULE-II	
Velocity Distribution in Laminar Flow: Different flow situations, steady state shell momentum balances, boundary conditions applicable to momentum transport problems, flow over a flat plate, flow through a circular tube, flow through annulus. steady state. shell energy balances: general boundary conditions applicable to energy transport problems of chemical engineering. heat conduction through compound walls. overall heat transfer coefficient.	**10 Hrs**
MODULE-III	
Temperature Distribution in Solids and in Laminar Flow: Different situations of heat transfer: heat conduction with internal generation by electrical and nuclear energy sources, heat conduction in a cooling fin: forced and free convection heat transfer. concentration Distributions in laminar flow: Steady state shell mass balances. general boundary conditions applicable to mass transport problems of chemical engineering. equimolar counter diffusion. numerical problems.	**10 Hrs**
MODULE-IV	
Concentration Distributions in Laminar Flow: Diffusion through stagnant gas and liquid films, diffusion with homogeneous reaction, diffusion with heterogeneous reaction-diffusion into falling film – forced convection mass transfer. numerical problems.	**10 Hrs**
MODULE-V	
Analogies between Momentum, Heat and Mass Transport: Analogies between momentum, heat and mass transport - Reynolds, Prandtl and Chilton & Colburn analogies. equations of change: equation of continuity, equation of motion;	**10 Hrs**

Navier – stokes equation. macroscopic balance for isothermal systems (mass, momentum, and mechanical energy balance).	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basic transport equations for momentum, heat & mass transfer.
CO2	Develop the mathematical model to develop flux equations for steady state momentum and energy transfer in various situations.
CO3	Develop mathematical models to determine transfer fluxes and temperature, concentration distribution for heat sources and systems involving diffusion.
CO4	Develop the flux equations for steady state mass transfer in various situations.
CO5	Apply equation of change in solving steady state problems & analyse analogies between momentum, heat and mass transport.

Reference Books	
1.	Transport phenomena, Bird, R. B., Stewart, W. E., & Lightfoot, E. N., Second Edition, 2006, John Wiley & Sons, ISBN: 9752843670
2.	Transport phenomena, B. M Suryavashi and L. R Dongre, Seventh Edition, 2013, Nirali Prakashann India, ISBN: 9381962561
3.	Transport phenomena, Brodkey, R. S., & Hershey, H. C., First Edition, 2003, Brodkey publishing, ISBN: 0972663592
4.	Transport Phenomena**,** J. W. Van Heuven, W. J. Beek, K. M. K. Muttzall, Second Edition, 1999, Wiley, ISBN: 0471999903

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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VII		
PROCESS INTENSIFICATION (Theory)		
Course Code:	**MVJ22CH742**	**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	

MODULE-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**
MODULE-II	
Process intensification through micro reaction technology: Effect of miniaturization on MODULE operations and reactions, Design rules, Implementation of Micro reaction Technology, Micro fabrication of reaction and MODULE 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**
MODULE-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**
MODULE-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**
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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:	**MVJ22CH743**	**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	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**
MODULE-V	
Bioelectronics: Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of MODULE 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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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:	**MVJ22CH744**	**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.	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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**

MODULE-V	
Hazards Identification: process hazards checklists, hazards surveys, hazards and operability studies, safety reviews, other methods, risk assessment: review of probability theory, event trees, fault trees, QRA and LOPA	**8 Hrs**

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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:	**MVJ22CH751**	**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	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.	

MODULE-I	
Introduction to energy – Global energy scene, Indian energy scene, MODULEs of energy, conversion factors, a general classification of energy, energy crisis, energy alternatives.	**8 Hrs**
MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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: VI		
FOOD TECHNOLOGY (Theory)		
Course Code:	**MVJ22CH752**	**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 MODULE 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.	

MODULE-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**
MODULE-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. MODULE 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**
MODULE-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**
MODULE-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.	
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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		
MATERIAL SCIENCE AND TECHNOLOGY (Theory)		
Course Code:	**MVJ22CH753**	**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 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.	

MODULE-I	
Introduction to Material Science: Introduction and structure of materials, why study properties of materials, Structure of atoms – quantum states, atomic bonding in solids, binding energy interatomic spacing, variation in bonding characteristics – single crystals polycrystalline, Non-crystalline solids, Imperfection in solids, Vacancies, Interstitials geometry of dislocation, Schmid´s law, Surface imperfection, Importance of defects, Microscopic techniques – grain size distribution.	**8 Hrs**
MODULE-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**
MODULE-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,	**8 Hrs**

Universal testing machine, vibrating sample magnetometer, Vector network analyzer, vibrating sample magnetometer, Brunauer-Emmett Teller surface areas, Zeta sizer, environmental mode.	
MODULE-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**
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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:	**MVJ22CH754**	**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.	
4	Relate safety, economics and human factors.	
5	Carry out risk assessment in process industries.	

MODULE-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**
MODULE-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**
MODULE-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**
MODULE-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	**8 Hrs**

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.	
MODULE-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 MODULE for 16 marks adding up to 80 marks. Each main question may have a maximum

of three sub divisions. Each MODULE will have internal choice in which both questions cover entire MODULE 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			
PROJECT PHASE – II			
Course Code	**MVJ22CHP76**	**CIE Marks**	**50**
Total No. of Contact Hours	**L : T : P :: 0 : 0 : 4**	**SEE Marks**	**50**
No. of Contact Hours/week	**-**	**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	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.