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

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

modified Euler's method, Runge-Kutta method of fourth-order. Differential Equations of second order: Runge-Kutta method and Milne's Predictor and Corrector method. Self study: Adams- Bash forth predictor and corrector methods Applications: Numerical Methods are used to provide „approximate" results for the differential equation problems being dealt with and their necessity is felt when it becomes impossible or extremely difficult to solve a given problem analytically.	
UNIT-V	
Optimization Techniques: Linear Programming, Mathematical formulation of linear programming problem (LPP), Graphical Method, Simplex Method, Dual simplex methods and Big M methods. **Self study:** Two phase simplex methods. **Applications:** Linear Programming is used in a variety of fields including food and agriculture, engineering,transportation problems, manufacturing and energy.	10 Hrs

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

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

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

High-3, Medium-2, Low-1

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

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

UNIT-V	
Energy Balance: General energy balance equation for steady state. Thermo chemistry, heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Standard heat of formation, standard heat of reaction, standard Heat of combustion, and calorific value of fuels. Calculation of ΔHR 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 Processes Principles. Part I: Material and Energy Balances, Hougen, O. A., Watson, K. M., & Ragatz, R. A. (1962), John Wiley and Sons.
2	Basic principles and calculations in chemical engineering, Himmelblau, D. M., & Riggs, J. B., (2012), FT press.
3.	Stoichiometry, Bhatt, B. I., & Thakore, S. B. (2010), Tata McGraw-Hill Education.
4	Elementary principles of chemical processes, Felder, R. M., Rousseau, R. W., & Bullard, L. G. (2020), John Wiley & Sons.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

High-3, Medium-2, Low-1

Semester: III		
MATERIAL SCIENCE FOR CHEMICAL ENGINEERS (Theory)		
Course Code:	MVJ21CH33	CIE Marks:50
Credits: L:T:P:	3:0:0	SEE Marks: 50
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To understand concepts on properties and selection of metals, ceramics, and polymers for design and Manufacturing.	
2	To identify the phase transformation that can be adopted to predict the various crystal structure of metals	
3	To determine Young's modulus of elasticity of the material of a given wire and heat treatment process	
4	To Study detailed information on types of corrosion and its prevention.	
5	To select the material of construction in automotive, structural, failure analysis and other types of industries	

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

Heat Treatment: Annealing, Normalizing Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Furnace types.	
UNIT-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
UNIT-V	
Typical engineering materials: Ferrous metals, non-ferrous metals and alloys, Aluminium and its alloys, Copper and its alloy, Lead and its alloy, Tin, Zinc and its alloy, silicon and its alloys**,** Alloys for high temperature service, Ceramic materials- structure of ceramics, polymorphism, Mechanical, electrical and thermal properties of ceramics phases, Refractories, Glasses, abrasives, plastics, fibes, and elastomers, Organic protective coating.	8 Hrs

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

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

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting

quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

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

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

High-3, Medium-2, Low-1

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

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

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

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

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

	working principle of agitation and mixing and describe the sampling of solid and conveying of it.

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

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

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

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

High-3, Medium-2, Low-1

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

UNIT-I	
Fluid statics and its applications – the concept of unit operations; introduction to momentum transfer, nature of fluids and pressure concept, variation of pressure with height – hydrostatic equilibrium, barometric equation; measurement of fluid pressure – manometers, continuous gravity decanter, centrifugal decanter. Fluid flow phenomena –the type of fluids; shear stress and velocity gradient relation, newtonian and non- newtonian fluids, the viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Reynolds stress, eddy viscosity; flow in boundary layers; Reynolds number, boundary layer separation, and wake formation.	8 Hrs
UNIT-II	
Basic equations of fluid flow -average velocity, mass velocity, continuity equation, Euler, and Bernoulli equations; modified equations for real fluids with correction factors; pump work in Bernoulli equation, angular momentum equation. The flow of incompressible fluids in conduits and thin layers - laminar flow through circular and non-circular conduits, Hagen Poiseuille	8 Hrs

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

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the concepts of fluid statics and dynamics to measure pressure and differentiate various flow phenomena.
CO2	Derive the fundamental equations and apply to solve various fluid flow problems.
CO3	Understand the various equations for incompressible and compressible fluids in conduits.
CO4	Demonstrate the knowledge of fluid flow principles in various types of flow measurements, transportation and metering of fluids using experimental techniques and applications to industry.
CO5	Develop functional relationships using dimensional analysis and similitude to solve technical problems also to analyse the flow past immersed bodies.

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part

– B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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

High-3, Medium-2, Low-1

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

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

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

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

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

High-3, Medium-2, Low-1

Semester: III		
ADDITIONAL MATHEMATICS-I (Common to all branches)		
Course Code:	MVJ21MATDIP-I	CIE Marks:50
Credits: L:T:P:	1:2:0	SEE Marks: 50
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To familiarize the important and introductory concepts of Differential calculus.	
2	Aims to provide essential concepts integral calculus.	
3	To gain knowledge of vector differentiation.	
4	To learn basic study of probability.	
5	Ordinary differential equations of first order and analyze the engineering problems.	

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

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the knowledge of calculus to solve problems related to polar curves and its applications.
CO2	Apply the concept of integration and variables to evaluate multiple integrals

	and their usage in computing the area and volumes.
CO3	Illustrate the applications of multivariate calculus to understand the solenoidal and irrotational vectors and also exhibit the inter dependence of line, surface and volume integrals.
CO4	Understand the basic Concepts of Probability.
CO5	Recognize and solve first-order ordinary differential equations occurring in different branches of engineering.

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

High-3, Medium-2, Low-1