



Engineering A Better Tomorrow

An Autonomous Institution

Bachelor of Engineering
in
Chemical Engineering

Scheme and Syllabus
(2025 Scheme)

III Semester

Vision of the Institute: `

Be an Institution of Excellence with International Standards.

Mission of the Institute:

- Impart quality education, along with industrial exposure.
- Provide world-class facilities to undertake research activities relevant to industrial and professional needs.
- Promote Innovation, Entrepreneurship and Value-added education that is socially relevant, along with economic benefits.

Department Vision:

Be a leading Chemical Engineering Department for quality technical education

Department Mission:

Quality Teaching: provide high-quality education in chemical and allied fields through outcome-based teaching-learning process

Core Competence: Empower students and faculty to achieve proficiency in chemical sciences and engineering using state-of – the art laboratory facilities with modern technologies.

Center for Excellence: Simulate and encourage the pursuit of excellence in chemical sciences and Engineering

Skill Development: Foster graduates with leadership qualities, entrepreneurship skills, innovative thinking and professional ethics.

Programme Outcomes (POs):

1. **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
3. **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole - life cost, net zero carbon, culture, society and environment as required.
4. **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research - based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

5. **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.
6. **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.
7. **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
8. **Individual and Collaborative Teamwork:** Function effectively as an individual, and as a member or leader in diverse/multi - disciplinary teams.
9. **Communication:** Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10. **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision - making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **Life - Long Learning:** Recognize the need for and have the preparation and ability for
 - i) independent and life - long learning
 - ii) adaptability to new and emerging technologies
 - iii) critical thinking in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

- **PSO1-** In-depth knowledge: Acquire in-depth knowledge of process calculations, transport operations, reaction engineering, process control, economics, safety and environmental aspects required to work in the diverse fields such as Petroleum refining, Nano technology, food, pharma, energy, environmental engineering etc
- **PSO2-** Computer aided Design: Solve Chemical engineering problems using computational and simulation tools for design and optimization of chemical processes.

PROGRAM EDUCATIONAL OBJECTIVES

- **PEO1- Fundamentals:** Graduates will apply chemical engineering principles in engineering practice for employability in Chemical and allied industries
- **PEO2- Higher Studies & Research:** Graduates will pursue their post-graduation and research in the fields of Chemical Engineering, Petrochemicals, Material Science, Biotechnology, Nanotechnology, Environmental Engineering and allied areas
- **PEO3- Entrepreneurship:** Graduates will apply fundamental knowledge in chemical engineering to nurture technologies for the benefit of humankind and to become successful entrepreneurs.

MVJ College of Engineering, Bengaluru (Autonomous)
B.E. in Chemical Engineering - Scheme 2025
 Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS)
 (Applicable for 2025-26 admitted students)

Semester - III

Sl. No	Course	Course Code	CourseTitle	Teaching& Learning Scheme					Examination				Credits
				CI		LI	TW& SL	# TH / S	Durationin hours	CIEMarks	SEEMarks	TotalMarks	
1	ASC	MVJ25CS31	Probability, Statistics and Stochastic Processes	56	0	0	64	120	3	50	50	100	4
2	IPCC	MVJ25CH32	Momentum Transfer	42	20	28	30	120	3	50	50	100	4
3	PCC	MVJ25CH33	Chemical Process Calculations	42	14	0	64	120	3	50	50	100	4
4	PCC	MVJ25CH34	Mechanical Unit Operations	42	28	0	20	90	3	50	50	100	3
5	PCC	MVJ25CH35	Computer Aided Numerical Methods in Chemical Engineering	42	14	0	64	120	3	50	50	100	4
6	PCCL	MVJ25CHL36	Mechanical Unit Operations Lab	0	0	28	2	30	3	50	50	100	1
7	AEC	MVJ25AECK37	Sustainable Engineering and SDGs	14	0	0	16	30	2	50	50	100	1
8	SDL	MVJ25CH38SL	Computing Techniques Lab	0	0	28	2	30	3	50	50	100	1
9	NCMC	MVJ25PE39	PhysicalEducation(PE)(Sportsand Athletics)	0	0	0	28	28	---	100	---	100	PP
		MVJ25YO39	Yoga										
10	NCMC	MVJ25MATDIP310	Additional Mathematics – I*	28	0	0	0	28	---	100	---	100	PP
TOTAL													22

*Applicable for Lateral entry students only

MVJ College of Engineering, Bengaluru (Autonomous) B.E. in Chemical Engineering - Scheme 2025 Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Applicable for 2025-26 admitted students)													
Semester – IV													
Sl. No	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIEMarks	SEEMarks	Total Marks	
				L	T	P	SL						
1	PCC	MVJ25CH41	Mass Transfer I	56	0	0	64	120	3	50	50	100	4
2	IPCC	MVJ25CH42	Process Heat Transfer	42	0	28	50	120	3	50	50	100	4
3	PCC	MVJ25CH43	Chemical Engineering Thermodynamics	56	0	0	64	120	3	50	50	100	4
4	PCC	MVJ25CH44	AIML for Chemical Engineers	42	0	0	48	90	3	50	50	100	3
5	PCCL	MVJ25CHL45	Thermodynamics Laboratory	0	0	28	2	30	3	50	50	100	1
6	BSC	MVJ25BI46	Biology for Engineers	28	0	0	32	60	2	50	50	100	2
7	AEC	MVJ25AECK47	Scientific Foundation of Health	14	0	0	16	30	2	50	50	100	1
8	SDL	MVJ25CH48SL	Process Flow Diagram Lab	0	0	28	2	30	3	50	50	100	1
9	NCMC	MVJ25PE49	Physical Education (PE) (Sports and Athletics)	0	0	0	28	28	---	100	---	100	PP
		MVJ25YO49	Yoga										
10	NCMC	MVJ25MATDIP410	Additional Mathematics – II*	28	0	0	28	28	---	100	---	100	PP
TOTAL													20

*Applicable for Lateral entry students only

MVJ College of Engineering, Bengaluru (Autonomous) B.E. in Chemical Engineering - Scheme2025 Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Applicable for 2025-26 admitted students)													
Semester – V													
Sl. No	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CI Marks	SE Marks	Total Marks	
				L	T	P	SL						
1	HSMC	MVJ25CH51	Industrial Project Management	42	0	0	48	90	3	50	50	100	3
2	IPCC	MVJ25CH52	Chemical Reaction Engineering	42	0	28	50	120	3	50	50	100	4
3	PCC	MVJ25CH53	Mass Transfer -II	42	0	0	48	90	3	50	50	100	3
4	PCC	MVJ25CH54	Chemical Process Industries	42	0	0	48	90	3	50	50	100	3
5	PEC	MVJ25CH55X	Professional Elective Course-I	42	0	0	48	90	3	50	50	100	3
6	BSC	MVJ25RM56	Research Methodology and IPR (Online)	28	0	0	32	60	2	50	50	100	2
7	AEC	MVJ25AECK57	Ability Enhancement Course	14	0	0	16	30	2	50	50	100	1
8	SDL	MVJ25CH58SL	Pollution Control and Instrumental Analysis Lab	0	0	28	2	30	3	50	50	100	1
9	PCCL	MVJ25CHL59	Mass Transfer Operations Lab	0	0	28	2	30	3	50	50	100	1
10	SDC	MVJ25HBP510	Hackathon-Based Project	0	0	0	60	60	---	50	50	100	2
TOTAL													23
Professional Elective Course-I													
MVJ25CH55A		Nanoscience and Nanotechnology		MVJ25CH55C		Petroleum Refining and Engineering							
MVJ25CH55B		Piping Engineering		MVJ25CH55D		Material Science and Technology							

MVJ College of Engineering, Bengaluru (Autonomous) B.E. in Chemical Engineering - Scheme2025 Outcome-BasedEducation(OBE)andChoice-BasedCreditSystem(CBCS) (Applicable for 2025-26 admitted students)													
VIIandVIIIsemestersforthecandidateswhooptforatwo-semesterinternshipalongwithCapstoneProject(SchemeB)													
Sl.No.	Course	Course Code	CourseTitle	Teaching& Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Durationin hours	CIEMarks	SEEMarks	TotalMarks	
				L	T	P	SL						
1	IPCC	MVJ25CH71	AI Enhanced Chemical Process Modelling & Simulation	42	0	28	50	120	3	50	50	100	4
2	PEC	MVJ25CH72X	ProfessionalElectiveCourse-III (NPTEL/VTU Online Course)	42	0	0	48	90	--	50	50	100	3
3	PEC	MVJ25CH73X	ProfessionalElectiveCourse-IV (NPTEL/VTU Online Course)	42	0	0	48	90	--	50	50	100	3
4	OEC	MVJ25CH74X	OpenElectiveCourse -I (NPTEL/VTUOnlinecourse)	42	0	0	48	90	---	50	50	100	3
5	SDC	MVJ25CH75	CapstoneProject-Phase-II	0	0	0	210	210	3	100	100	200	7
6	NCMC	MVJ25IKS76	IndianKnowledgeSystem	14	0	0	14	28	--	100	--	100	PP
7	AEC	MVJ25AECK77	Ability Enhancement Course	14	0	0	16	30	2	50	50	100	1
8	SDL	MVJ25CH78SL	Process Simulation Lab	0	0	28	2	30	3	50	50	100	1
	Total												22
1	PEC	MVJ25CH81X	ProfessionalElective-V (NPTEL/VTUOnlineCourse)	42	0	0	48	90	---	50	50	100	3
2	OEC	MVJ25CH82X	OpenElective-II (NPTEL/VTUOnlineCourse)	42	0	0	48	90	---	50	50	100	3
3	SDC	MVJ25INT83X	Internship(Two-semesterinternshipfora minimum Period of 180 working days or -30 weeks)	--	--	--	--	360	3	50	50	100	9
	Total												15
	VII semesterand VIII semesterCreditsTotal												37

Professional Elective Course-III			
MVJ25EA72A	NPTEL/VTUOnlineCourse	MVJ25EA72C	NPTEL/VTUOnlineCourse
MVJ25EA72B	NPTEL/VTUOnlineCourse	MVJ25EA72D	NPTEL/VTUOnlineCourse
Professional Elective Course-IV			
MVJ25EA73A	NPTEL/VTUOnlineCourse	MVJ25EA73C	NPTEL/VTUOnlineCourse
MVJ25EA73B	NPTEL/VTUOnlineCourse	MVJ25EA73D	NPTEL/VTUOnlineCourse
Open Elective Course-I			
MVJ25EA74A	NPTEL/VTUOnlineCourse	MVJ25EA74C	NPTEL/VTUOnlineCourse
MVJ25EA74B	NPTEL/VTUOnlineCourse	MVJ25EA74D	NPTEL/VTUOnlineCourse
Professional Elective Course-V			
MVJ25EA81A	NPTEL/VTUOnlineCourse	MVJ25EA81C	NPTEL/VTUOnlineCourse
MVJ25EA81B	NPTEL/VTUOnlineCourse	MVJ25EA81D	NPTEL/VTUOnlineCourse
Open Elective Course-II			
MVJ25EA82A	NPTEL/VTUOnlineCourse	MVJ25EA82C	NPTEL/VTUOnlineCourse
MVJ25EA82B	NPTEL/VTUOnlineCourse	MVJ25EA82D	NPTEL/VTUOnlineCourse

Types of Internships (Course Code: MVJ25INT83X)

Students shall undertake one of the following internship types during the eighth semester, as per academic guidelines:

1. **MVJ25INT83A–Industry Internship:** Shall involve practical exposure and training within an industrial or corporate setting.
2. **MVJ25INT83B–Research Internship:** Shall focus on academic or applied research under the guidance of faculty or research institutions.
3. **MVJ25INT83C–Post-Placement Internship:** Shall be undertaken by students who have secured placement, aligning with their future employment domain.
4. **MVJ25INT83D–Societal Internship:** Shall engage students in community-based or social impact projects with NGOs, government bodies, or civic organizations.
5. **MVJ25INT83E–Online Internship:** Shall be conducted through recognized digital platforms offering structured internship modules.
6. **MVJ25INT83F–Skill Enhancement Courses (SEC):** Shall be opted by students unable to secure internships, offering credit equivalence through curated online courses available at [http:// www.online.vtu.ac.in](http://www.online.vtu.ac.in)

To ensure uniformity, quality, and transparency in the internship process, **VTU has launched a centralized web portal** that serves as a **single platform** for all internship opportunities. **Reputed industries, Centers of Excellence, Research Laboratories, and other recognized bodies will be registered on this portal. Students must choose internships exclusively through this portal. No other mode of internship selection will be permitted.**

Semester: III			
Probability, Statistics and Stochastic Processes (CSE, AIML, CSE (Data Science), ISE, CSD, CH, CV)			
Course Code:	MVJ25CS31	CIE Marks:	50
L:T:P:S	56:0:0:64	SEE Marks:	50
Credits:	4	Total:	100
Hours:	120	SEE Duration:	3 Hrs
Course Objectives: This course will give ability to: - Understand and apply probability distribution, sampling theory and joint probability distributions. - Organize, manage and present data using statistical methods.			
Syllabus			
Random variables and probability distributions, discrete and continuous distributions, probability mass and density functions, Binomial, Poisson, Exponential, Uniform and Normal distributions, joint probability distributions, expectation, covariance and correlation; Sampling theory, sampling distributions, standard error, hypothesis testing, confidence limits, t-distribution, Chi-square and F-test distributions; Markov chains, states, transitions, transition probabilities, transition matrices, state and chain classification, and Gambler's Ruin; Statistical methods - correlation, regression, curve fitting using least-squares methods, and K-means clustering; Design of experiments using ANOVA, one-way and two-way classifications, completely randomized design, randomized block design, and Latin square design.			
Course Plan			
Module I			
Probability Distributions			
SL No.	Topics to be covered	Hours required	
1	Random variables (discrete and continuous), probability mass/density functions.	11 Hrs	
2	Binomial distribution, Poisson distribution.		
3	Exponential, Uniform and Normal distributions.		
4	Joint Probability distribution for two discrete random variables.		
5	Expectation, covariance, correlation coefficient.		
Module II			
Sampling Theory			
SL No.	Topics to be covered	Hours required	
1	Sampling, Sampling distributions, Standard error.	12 Hrs	
2	Test of hypothesis for means.		
3	Test of hypothesis for Proportions.		
4	Confidence limits for means.		
5	Student's t-distribution.		

6	Chi-square distribution.	
7	F – test distribution.	
Module III		
Markov Chains		
SL No.	Topics to be covered	Hours required
1	States and transitions, Transition probabilities.	11 Hrs
2	General two-state Markov chain.	
3	Powers of the transition matrix for the m-state chain.	
4	Gambler's ruin as a Markov chain.	
5	Classification of states.	
6	Classification of chains.	
Module IV		
Statistical Methods		
SL No.	Topics to be covered	Hours required
1	Correlation Coefficients.	11 Hrs
2	Regression Coefficients.	
3	Line of regression problems.	
4	Fitting of the curves of the form $y = ax + b$.	
5	Fitting of the curves of the form $y = ax^2 + bx + c$.	
6	Fitting of the curves of the form $y = ae^{bx}$ by the method of least squares.	
7	K-Clustering: Definition & Basic Problems.	
Module V		
Design of Experiments (ANOVA):		
SL No.	Topics to be covered	Hours required
1	Design of Experiments (ANOVA): One-way classifications.	11 Hrs
2	Design of Experiments (ANOVA): Two-way classifications.	
3	Completely randomized design.	
4	Randomized block design.	
5	Latin square design.	
Textbooks:		
1. B.S. Grewal, <i>Higher Engineering Mathematics</i>, Khanna Publishers, 45th Edition, 2023. 2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye, <i>Probability and Statistics for Engineers and Scientists</i>, Pearson, 10th Edition, 2018. 3. T. Veerarajan, <i>Probability, Statistics and Random Processes</i>, 3rd Edition, 2016, McGraw Hill Education. 4. A. M. Haghighi, I. Wickramasinghe, E. A. Appiah, <i>Probability, Statistics, and Stochastic Processes for Engineers and Scientists</i>, 1st Edition, 2020, CRC Press.		
Reference Books:		
1 Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition, 2014.		

- 2 S.C. Gupta and V.K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, Latest Edition.
- 3 Sheldon M. Ross, *Introduction to Probability Models*, Academic Press, 12th Edition, 2019.

Other References:

Ex: NPTEL, SWAYAM:

- 1 https://youtu.be/ZfbWC4rqIiE?si=_Q91xzGzM4fyJ1PC
- 2 <https://youtu.be/RwauwRcJOhA?si=WQH2j8cpb62kDymS>
<https://youtu.be/6zslEdMGGiQ?si=GPIImZMvCHNdMoGoS>
- 3 <https://youtu.be/Q0z4YKfrlMM?si=YQersroRgW5R7nCW>
- 4 <https://youtu.be/n9qpktdFfLU?si=9OJPAIaUdK-TANGK>
- 5 <https://youtu.be/AuDgWSx7gMo?si=9W5b7EJa-j8W4iAP>

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Apply probability distributions to engineering problems.

CO2: Perform sampling and hypothesis testing.

CO3: Analyze Markov chains and stochastic processes.

CO4: Apply regression and curve fitting techniques.

CO5: Use statistical and analytical methods for decision making.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	-	-	-	-	-	-	-	3	2
CO2	3	3	2	3	-	-	-	-	-	-	-	3	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3
CO4	3	3	3	3	-	-	-	-	-	-	1	2	3
CO5	3	2	2	3	-	-	-	-	-	-	2	2	3

High-3: Medium-2: Low-1

The Evaluation Method

Continuous Internal Evaluation (CIE):

- Three Internal Tests will be conducted for 50 marks each and average of three will be taken. The student should score minimum 30% marks of the average of the three tests to avoid NSSR. (A).
- Alternative Assessment Tools (AAT) are used to complete a project / Quiz/ Seminar cum Presentation / other suitable alternate assessment methods for 30 marks. Two evaluations will be conducted (B).
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C).

Final CIE Marks will be calculated as $(A+B+ C)/2$ for 50 marks.

Semester End Examination (SEE):

The question paper consists of two parts, A and B.

Part A: Consists of 10 questions (2 questions from each module) of 2 marks each.

Part B: The question paper should have 10 questions. Each question carries 16 marks. There should be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The Final mark for the course is sum of the CIE and SEE Marks.

Semester:III			
MOMENTUM TRANSFER			
Course Code:	MVJ25CH32	CIE Marks:	50
L:T:P:S	42:20:28:30 (IPCC)	SEE Marks:	50
Credits:	4	Total:	100
Hours:	120	SEE Duration:	3 Hrs
Course Objectives: This course will give ability to: - Understand concepts 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. - Understand the relationship between kinetic energy, potential energy, internal energy, and work complex flow systems using Bernoulli's equation with application to industrial problems - 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 - Study Dimensional analysis and working of pumps, transportation, and metering of fluids using various techniques and applications to industry			
Syllabus			
Study of fluid properties, pressure measurement, hydrostatic equilibrium, viscosity, Newtonian and non-Newtonian fluids, and various fluid flow phenomena. The syllabus includes laminar and turbulent flow, Reynolds number, boundary layer concepts, continuity, Euler and Bernoulli equations, flow in pipes and channels, friction losses, compressible and incompressible fluid flow, flow measurement devices, transportation and metering of fluids, pumps, compressors, blowers, fluidization, flow past immersed bodies, drag forces, dimensional analysis, and the application of fluid mechanics principles in chemical process industries.			
Course Plan			
Module I			
Sr.No	Topics to be covered	Hours required	
1	Fluid statics and its applications – the concept of unit operations; introduction to momentum transfer	9-Hrs	
2	Nature of fluids and pressure concept, variation of pressure with height		
3	Hydrostatic equilibrium, barometric equation		
4	Measurement of fluid pressure – manometers, continuous gravity decanter, centrifugal decanter.		
5	Fluid flow phenomena –the type of fluids; shear stress and velocity gradient relation,		
6	Newtonian and non- Newtonian fluids, the viscosity of gases and liquids.		
7	Types of flow – laminar and turbulent flow, Reynolds stress, eddy viscosity;		
8	Flow in boundary layers; Reynolds number, boundary layer separation, and wake formation		
Module II			
Sr.No	Topics to be covered	Hours required	
1	Basic equations of fluid flow -average velocity, mass velocity	8-Hrs	
2	Continuity equation		
3	Euler, and Bernoulli equations		
4	Modified equations for real fluids with correction factors;		

5	Pump work in Bernoulli equation,	
6	Angular momentum equation.	
Module III		
Sr.No	Topics to be covered	Hours required
1	The flow of incompressible fluids in conduits and thin layers -laminar flow through circular and non-circular conduits	9-Hrs
2	Hagen Poiseuille equation	
3	Laminar flow of non-Newtonian liquids	
4	Turbulent flow in pipes and closed channels	
5	Friction factor chart, friction from changes in velocity or direction, form friction losses in Bernoulli equation, flow of fluids in thin layers	
6	The flow of compressible fluids - continuity equation, Mach number, total energy balance	
7	The velocity of sound, Ideal gas equations, flow through variable-area conduits,	
8	Adiabatic frictional flow, isothermal frictional flow (elementary treatment only).	
Module IV		
Sr.No	Topics to be covered	Hours required
1	Transportation and metering of fluids - pipes, fittings, and valves	8-Hrs
2	Flow measuring devices - venturi meter, orifice meter, rotameter, and pitot tube	
3	The elementary concept of target meter, vortex-shedding meters, turbine meters	
4	Positive displacement meters, magnetic meters	
5	Coriolis meters, and thermal meters	
6	Flow through open channel-weirs and notches	
7	Performance and characteristics of pumps-positive displacement and centrifugal pumps	
8	Fans, compressors, and blowers	
Module V		
Sr.No	Topics to be covered	Hours required
1	Flow of fluid past immersed bodies: Drag, drag coefficient,	8-Hrs
2	Pressure drop – Kozeny-Carman equation, Blake-Plummer, Ergun equation	
3	Fluidization: - conditions for fluidization	
4	Minimum fluidization velocity, Pneumatic conveying, Industrial application of Fluidization.	
5	Dimensional analysis: Dimensional homogeneity	
6	Rayleigh's, Buckingham Π - method.	
7	Significance of different dimensionless numbers	
Laboratory Experiments		28 Hrs
1. Friction in circular pipes. 2. Friction in non-circular pipes. 3. Flow measurement using venturi meter (incompressible fluid 4. Flow measurement using orifice meters (incompressible fluid). 5. Flow over notches - find the coefficient of discharge through various notches 6. Flow over rectangular notches- generalized correlation between Reynold's number & friction factor 7. Flow through open orifice-Hydraulic coefficients 8. Verification of Bernoulli's Theorem 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 pump		

12. Study of various pipe fittings and their equivalent lengths.

Any 10 experiments to be conducted

Textbooks:

1. McCabe, W. L., Smith, J. C., & Harriott, P., "Unit operations of chemical engineering", ISBN: 9780071247108, 0071247106, New York: McGraw-Hill, 2005,
2. Bansal, R. K., "A textbook of fluid mechanic", Laxmi Publication (P) Ltd., 2005,

Reference Books:

1. Engineering fluid mechanics, Kumar, K. L., 4th edn, New Delhi: Eurasia, 1988,
2. Chemical Engineering, Coulson J.H. and Richardson J.F., Vol-I, 5th edition, 1998.

Other References:

Ex: NPTEL, SWAYAM...etc

1. <https://nptel.ac.in/courses/103104044>

2. <https://nptel.ac.in/courses/103104043>

3. <https://nptel.ac.in/courses/103102211>

Course Outcomes:

At the end of the course, the student 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 analyze the flow past immersed bodies

CO-PO Mapping

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

High-3: Medium-2: Low-1

Evaluation Method

Continuous Internal Evaluation (CIE):

- Three Internal Tests will be conducted for 50 marks each and average of three will be taken. The student should score minimum 30% marks of the average of the three tests to avoid NSSR. (A).

- Alternative Assessment Tools (AAT) are used to complete a project / Quiz/ Seminar cum Presentation / other suitable alternate assessment methods for 30 marks. Two evaluations will be conducted (B).
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C).

Final CIE Marks will be calculated as $(A+B+ C)/2$ for 50 marks.

Continuous Internal Evaluation (CIE) for Practical:

- **Weekly Evaluation for 30 Marks:** Weekly evaluation should be conducted for every experiment. Marks of each evaluation includes Preparedness / Observation (6 Marks) + Experiment Conduction/ Execution (9 Marks) + Viva Voce (9 Marks) + Record Book (6 Marks) for each experiment. All weekly marks are added and scaled to 30 marks (C).
- Two CIE tests for 20 Marks each should be conducted and averaged to 20 Marks. The student should score minimum 30% in the average test marks (i.e. 6 marks) to avoid NSSR. (D).

Final CIE Marks of practical should be calculated as C+D for 50 marks

For IPCC, Final CIE Marks will be calculated as Sum of Theory CIE and Practical CIE for 100 marks.

Semester End Examination (SEE) for Theory:

The question paper consists of two parts, A and B.

Part A: Consists of 10 questions (2 questions from each module) of 2 marks each.

Part B: The question paper should have 10 questions. Each question carries 16 marks. There should be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (X).

Semester End Examination (SEE) for Practical:

The SEE of practical is evaluated for 50 marks, distributed as follows:

- Experiment Conduction with Results: 40 marks
- Viva Voce: 10 marks
- Total 50 marks (Y)

The Final mark for the SEE is X+Y of total 100 marks

The Final mark for the course is the sum of CIE and SEE marks, scaled to 100.

Semester:III			
Chemical Process Calculations			
Course Code:	MVJ25CH33	CIE Marks:	50
L: T:P:S	42:14:0:64	SEE Marks:	50
Credits:	4	Total:	100
Hours:	120	SEE Duration:	3 Hrs
Course Objectives: This course will give ability to: - Introduce the fundamental concepts of units, dimensions, mole concept, concentration, gas laws and process variables required for chemical engineering calculations. - Develop systematic approaches for performing steady-state material balances on non-reactive and reactive chemical processes. - Familiarize students with stoichiometry, combustion calculations, recycle, bypass and purge operations encountered in chemical processes - Explain and apply the principles of energy balances and thermochemistry to chemical process systems, including reactive and adiabatic processes. - Develop the ability to formulate and solve unsteady-state material and energy balance problems using analytical and introductory numerical methods.			
Syllabus			
Fundamentals of units, dimensions, mole concept, concentration calculations, gas laws, process variables, and process flow diagrams. The course covers steady-state material balances for non-reactive and reactive systems, stoichiometry, combustion calculations, limiting and excess reactants, conversion, yield, selectivity, recycle, bypass and purge operations. Energy balance concepts such as enthalpy, heat capacity, heat of reaction, combustion, thermochemistry, adiabatic processes, and integrated material and energy balances are included. Unsteady-state material and energy balances along with analytical and numerical solution techniques for transient systems are also studied			
Course Plan			
Module I			
FUNDAMENTALS OF CHEMICAL PROCESS CALCULATIONS			
Sr. No	Topics to be covered		Hours required
1	Units and dimensions; fundamental and derived units, SI and commonly used engineering units		11-Hrs
2	unit conversion and dimensional consistency		
3	Mole concept; atomic and molecular weights; mass and mole fractions; percentage composition		
4	Concentration scales including molarity, molality, normality and ppm. Density, specific gravity and their application in process calculations.		
5	Ideal gas law; calculation of gas density, specific volume and volume changes with temperature and pressure; gas mixtures and partial pressures		
6	Basis of calculation and process variables. Introduction to process flow diagrams, process streams and process units		
7	Basic degrees-of-freedom concept: identification of unknowns, independent equations and process specifications.		
Module II			
STEADY-STATE MATERIAL BALANCES FOR NON-REACTIVE SYSTEMS			
Sr. No	Topics to be covered		Hours required
1	General material balance equation and conservation of mass; steady-state material balances; total and component balances		

2	Material balances for single-unit and multiple-unit processes	12-Hrs
3	Overall and individual-unit balances	
4	Basis selection and process flow-sheet calculations	
5	Application of the basic degrees-of-freedom concept to simple single-unit and multiple-unit systems	
6	Material balances on mixing and blending, splitting and combining of streams, and simple evaporation and concentration processes	
7	Preparation and interpretation of simple process flow sheets and systematic solution of multi-unit material-balance problems.	
Module III REACTIVE MATERIAL BALANCES, COMBUSTION AND RECYCLE SYSTEMS		
Sr. No	Topics to be covered	Hours required
1	Stoichiometry of chemical reactions; limiting and excess reactants; fractional and percentage conversion.	11-Hrs
2	Yield and selectivity	
3	Extent of reaction and its application to material balances involving single and multiple reactions.	
4	Reactive material balances involving single and multiple reactions	
5	Combustion calculations including theoretical air, excess air, air-fuel ratio and flue-gas composition on wet and dry basis.	
6	Ultimate and proximate analysis of fuels.	
7	Recycle, bypass and purge systems; recycle ratio and inert accumulation	
8	Material balances involving recycle and reactive recycle systems, including single-pass and overall conversion.	
9	Application of basic degrees-of-freedom concepts to selected reactive and recycle systems.	
Module IV ENERGY BALANCES & THERMOCHEMISTRY		
Sr. No	Topics to be covered	Hours required
1	Forms of energy; internal energy and enthalpy; heat and work.	11-Hrs
2	General energy balance for open and closed systems	
3	Steady-state energy balances	
4	Heat capacity of solids, liquids and gases; sensible heat and phase-change energy	
5	Standard heat of formation, heat of reaction and heat of combustion; calorific value of fuels and Hess's law.	
6	Temperature dependence of heat of reaction using Kirchhoff's equation	
7	Energy balances involving chemical reactions; heat requirements and heat removal	
8	Adiabatic reaction and flame temperatures for simple systems	
9	Energy balances on reactors and selected process units. Integrated steady-state material and energy balances	
Module V Unsteady-State Material and Energy Balances		
Sr. No	Topics to be covered	Hours required
1	Steady-state and unsteady-state processes; accumulation term and general transient material balance	
2	Unsteady-state material balances for filling and emptying tanks, mixing and dilution,	

	batch and semi-batch systems.	11-Hrs
3	Transient material balances involving simple chemical reactions and concentration-time relationships.	
4	Formulation of differential equations from material balances and application of initial conditions	
5	Analytical solution of simple first-order transient systems	
6	Unsteady-state energy balances for heating and cooling of batch systems	
7	Coupled transient material and energy balances	
8	Introduction to numerical solution of transient balance equations using Euler and Runge–Kutta (RK4) methods, with interpretation of concentration and temperature profiles as functions of time.	

Textbooks:

- 1 Hogen, O. A., Watson, K. M., and Ragatz, R. A, "Chemical Process Principles. Part I: Material and Energy Balances", John Wiley and Sons,1962
- 2 Himmelblau, D. M., & Riggs, J. B., "Basic principles and calculations in chemical engineering", FT press, 2012
- 3 Bhatt, B. I., & Thakore, S. B, "Stoichiometry", Tata McGraw-Hill Education,2010.
- 4 Narayanan, K.V., & Lakshmikutty, B. (2016). Stoichiometry and Process Calculations. PHI Learning.

Reference Books:

1. Felder, R. M., Rousseau, R. W., & Bullard, L. G. , "Elementary principles of chemical processes", John Wiley & Sons,2020
2. Smith, J. M., Van Ness, H. C., & Abbott, M. M. (2005). Introduction to Chemical Engineering Thermodynamics. McGraw Hill.

Other References:

Ex: NPTEL,SWAYAM...etc

1.<https://nptel.ac.in/courses/103103165>

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Apply units, dimensions, mole concepts, concentration scales, gas laws and process variables to solve basic chemical engineering calculation problems.

CO2: Formulate and solve steady-state material balances for non-reactive single-unit and multiple-unit processes using appropriate bases and basic degrees-of-freedom concepts.

CO3: Solve reactive material-balance, combustion, recycle, bypass and purge problems using stoichiometric relationships, conversion, yield and selectivity.

CO4: Formulate and solve material and energy balance problems involving sensible heat, phase change, heat of reaction, combustion and adiabatic processes.

CO5: Formulate and solve simple unsteady-state material and energy balance problems and apply analytical and basic numerical methods such as Euler and RK4 to predict transient concentration and temperature profiles

CO-PO Mapping

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

High-3: Medium-2: Low-1

Evaluation Method

Continuous Internal Evaluation (CIE):

- Three Internal Tests will be conducted for 50 marks each and average of three will be taken. The student should score minimum 30% marks of the average of the three tests to avoid NSSR. (A).
- Alternative Assessment Tools (AAT) are used to complete a project / Quiz/Seminar cum Presentation / other suitable alternate assessment methods for 30 marks. Two evaluations will be conducted (B).
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C).

Final CIE Marks will be calculated as $(A+B+C)/2$ for 50 marks.

Semester End Examination (SEE):

The question paper consists of two parts, A and B.

Part A: Consists of 10 questions (2 questions from each module) of 2 marks each.

Part B: The question paper should have 10 questions. Each question carries 16 marks. There should be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The Final mark for the course is sum of the CIE and SEE Marks.

Semester:III			
Mechanical Unit Operations			
Course Code:	MVJ25CH34	CIE Marks:	50
L: T:P:S	42:28:0:20	SEE Marks:	50
Credits:	3	Total:	100
Hours:	90	SEE Duration:	3 Hrs
Course Objectives: This course will give ability to: • Study different properties of particulate solids. • Study principles of comminution and different types of equipment for size reduction like crushers • Understand mechanical separation aspect such as screening. • Understand energy requirements in solids handling			
Syllabus			
Particle technology concepts including particle size, shape, sphericity, size analysis, screening and industrial screening equipment. Topics include size reduction principles, crushing and grinding laws, energy requirements, crushers, grinders and mills. Filtration theory, filter media, industrial filters, centrifugal filtration and filter aids are covered. The syllabus also includes motion of particles through fluids, settling behavior, sedimentation theories, thickener design, agitation and mixing equipment, power consumption in mixing operations, storage and conveying of solids, and separation processes such as cyclones, hydrocyclones, magnetic separation and electrostatic separation.			
Course Plan			
Module I			
Sr. No	Topics to be covered		Hours required
1	Particle Technology: particle shape, particle size		8-Hrs
2	Different ways of expression of particle size		
3	Shape factor, sphericity		
4	Particle size analysis; screens – ideal and actual screens		
5	Tyler series, differential and cumulative size analysis		
6	Effectiveness of screen, specific surface of a mixture of particles, number of particles in a mixture, standard screens, motion of screen		
7	Industrial screening equipment- Grizzly, Gyratory screen, Vibrating screen, Trommels,		
8	Sub sieve analysis – air permeability test, air elutriation, beaker decantation.		
Module II			
Sr. No	Topics to be covered		Hours required
1	Size Reduction: Introduction – types of forces used for comminution, criteria for comminution		8-Hrs
2	Characteristics of comminute products		
3	Laws of size reduction, work index, energy utilization		
4	Methods of operating crushers – free crushing, choke feeding, open circuit grinding, closed circuit grinding, wet and dry grinding		
5	Equipment for size reduction – classification of size reduction		
6	Equipment; equipment – blake jaw crusher, gyratory crusher, smooth roll crusher, toothed roll crusher, impactor, ball mill		
7	Critical speed of ball mill; cutters – knife cutter, ultrafine grinder-fluid energy mill,		

	colloid mill.	
Module III		
Sr. No	Topics to be covered	Hours required
1	Filtration: Introduction, classification of filtration, cake filtration, clarification	8-Hrs
2	Batch, and continuous filtration	
3	pressure and vacuum filtration	
4	Derivation of constant rate filtration and constant pressure filtration	
5	Characteristics of filter media; industrial filters-sand filter, filter press	
6	Leaf filter, rotary drum filter; principles of centrifugal filtration,	
7	Rate of washing – suspended batch centrifuge,	
8	Filter aids, application of filter aids.	
Module IV		
Sr. No	Topics to be covered	Hours required
1	The motion of particles through fluids: mechanics of particle motion	9-Hrs
2	The equation for one-dimensional motion of particles through a fluid in the gravitational and centrifugal field	
3	Terminal velocity, motion of spherical particles in Stokes's region, Newton's region, and intermediate region	
4	The criterion for settling regime, hindered settling modification of equation for hindered settling	
5	Sedimentation: Batch settling test, Coe and Clevenger theory	
6	Kynch theory	
7	Thickener design	
8	Equipment: Gravity Settling Tank, Disk Bowl Centrifuge	
Module V		
Sr. No	Topics to be covered	Hours required
1	Agitation and mixing: application of agitation, agitation equipment	9-Hrs
2	Types of impellers – propellers, paddles and turbines,	
3	Flow patterns in agitated vessels prevention of swirling, standard turbine design, power correlation and power calculation	
4	Mixing of solids, mixing index, types of mixers –, muller mixers, mixing index, ribbon blender, internal screw mixer	
5	Sampling, storage and conveying of solids: sampling of solids, storage of solids, open and closed storage, bulk and bin storage,	
6	Conveyors – belt conveyers, chain conveyor, apron conveyor,	
7	Bucket conveyor, screw conveyor.	
8	Miscellaneous separation: centrifugal separators: cyclones and hydro cyclones, magnetic separation, electrostatic separation	
Textbooks:		
1. McCabe, W. L., Smith, J. C., & Harriott, P, "Unit Operations of Chemical Engineering",7 th edition. McGraw-hill,1993		
2. CM Narayanan, BC Bhattacharya, "Mechanical Operations for Chemical Engineers", Khanna Publications		
3. Hiremath and Kulkarni , "Mechanical Operations (Unit Operations) of Chemical Engineering,", Everest Publications		

Reference Books:

3. Badger, W. L., & Banchero, J. L. "Introduction to Chemical Engineering. " 4th ed. McGraw-hill, 2010
4. Richardson J.F., Coulson J.M, Backhurst J.R, and Harker J.H."Particle Technology and Separation Processes". 5th edition, Elsevier,2002
5. Brown G.G, "Unit Operations". CBS Publisher,2018

Other References:

Ex: NPTEL,SWAYAM...etc

1.<https://nptel.ac.in/courses/103103153>

2.<https://nptel.ac.in/courses/103107127>

Course Outcomes:

At the end of the course, the student 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.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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

Evaluation Method**Continuous Internal Evaluation (CIE):**

- Three Internal Tests will be conducted for 50 marks each and average of three will be taken. The student should score minimum 30% marks of the average of the three tests to avoid NSSR. (A).
- Alternative Assessment Tools (AAT) are used to complete a project / Quiz/Seminar cum Presentation / other suitable alternate assessment methods for 30 marks. Two evaluations will be conducted (B).
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C).

Final CIE Marks will be calculated as (A+B+ C)/2 for 50 marks.

Semester End Examination (SEE):

The question paper consists of two parts, A and B.

Part A: Consists of 10 questions (2 questions from each module) of 2 marks each.

Part B: The question paper should have 10 questions. Each question carries 16 marks. There should be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The Final mark for the course is sum of the CIE and SEE Marks.

Semester:III			
Computer Aided Numerical Methods in Chemical Engineering			
Course Code:	MVJ25CH35	CIE Marks:	50
L: T:P:S	42:14:0:64	SEE Marks:	50
Credits:	4	Total:	100
Hours:	120	SEE Duration:	3 Hrs
Course Objectives: This course will give ability to: - Understand digital programming using diverse software tools which enable active learners to create programs for problem solving in Chemical Engineering - Enhance data analysis via transformation and visualization of specified engineering datasets using software tools, - Familiarize with numerical analysis using software tools for determining plausible solutions to Chemical Engineering problems - Develop mathematical models for Chemical Engineering Systems and perform simulation via tools for getting beneficial cognitive insights of models' performance - Apply computational techniques to determine the solutions of complex problems which arise in Chemical Engineering circumstances			
Syllabus			
Programming fundamentals using tools such as MATLAB, Python, Excel and related software, including logical operations, data structures, functions and classes. The course emphasizes data handling, processing and visualization through graphical techniques and engineering datasets. Numerical methods for solving linear and nonlinear equations, regression, interpolation and engineering calculations are covered. Mathematical modelling, solution of ordinary and partial differential equations, computer simulation of chemical engineering systems, machine learning fundamentals, predictive modelling and real-world chemical engineering case studies form important components of the syllabus.			
Course Plan			
Module I			
Sr. No	Topics to be covered		Hours required
1	Introduction to Computing in Chemical Engineering: Overview of programming with tools		11-Hrs
2	Basic programming development via tools		
3	Logical operations and control and data structures		
4	Functions/Classes or equivalent higher programming concepts		
Module II			
Sr. No	Topics to be covered		Hours required
1	Data Handling and Visualization: Handling of input and output datafiles using different software tools and mathematical operations of datasets considered		11-Hrs
2	Creating two-dimensional visualization via line-plot, bar charts, pie charts and so on		
3	Making three-dimensional plots		
4	Application in Chemical Engineering Problem Solving		
Module III			
Sr. No	Topics to be covered		Hours required
1	Numerical Methods: Linear and Nonlinear Equations		11-Hrs
2	Linear and Nonlinear Regression		
3	Interpolation		
4	Application in Chemical Engineering Problem Solving of linear and nonlinear expressions including nonlinear regression		

Module IV		
Sr. No	Topics to be covered	Hours required
1	Differential Equations: Initial Value Problems in Chemical Engineering	11-Hrs
2	Multivariable differential equations	
3	Partial Differential Equations in Chemical Engineering	
4	Real-World Case-studies of Chemical Engineering circumstances	
Module V		
Sr. No	Topics to be covered	Hours required
1	Application of computing in Chemical and Biochemical Engineering	12-Hrs
2	Introduction to Machine Learning in Chemical Engineering	
3	Supervised Learning applications in Chemical Engineering Problem Solving	
4	Real-World Case-studies of ML application using Chemical Reaction Kinetics/Process Control lab datasets.	
Textbooks: 1. Holly Moore , " MATLAB For Engineers", 6th Edition, , Pearson education		
Reference Books: 1. Yeong Koo Yeo,"Chemical Engineering Computation with MATLAB". 2 nd Edition, CRC Press 2. Kenneth J. Beers , "Numerical Methods for Chemical Engineering: Applications in MATLAB", Cambridge Press		
Other References: Ex: NPTEL,SWAYAM...etc 1. https://nptel.ac.in/courses/103105220 2. https://nptel.ac.in/courses/103106118		
Course Outcomes: At the end of the course, the student will be able to: CO1: Developing innovatively computer programs for the wider contexts of problems, demonstrate an understanding of variables, arrays, and logical operations, and apply control structures in their scripts CO2: Proficient in importing and preprocessing data using tools, creating various types of graphical illustrations to visualize datasets, and dissemination CO3: applying numerical methods for finding solutions to diverse circumstances of Chemical Engineering problems CO4: Ability to develop mathematical models and creating programs using varieties of tools for performance evaluation CO5: Understanding Machine Learning applications in Chemical Engineering for problem solving via predictive modelling framework		

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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

Evaluation Method

Continuous Internal Evaluation (CIE):

- Three Internal Tests will be conducted for 50 marks each and average of three will be taken. The student should score minimum 30% marks of the average of the three tests to avoid NSSR. (A).
- Alternative Assessment Tools (AAT) are used to complete a project / Quiz/Seminar cum Presentation / other suitable alternate assessment methods for 30 marks. Two evaluations will be conducted (B).
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C).

Final CIE Marks will be calculated as $(A+B+C)/2$ for 50 marks.

Semester End Examination (SEE):

The question paper consists of two parts, A and B.

Part A: Consists of 10 questions (2 questions from each module) of 2 marks each.

Part B: The question paper should have 10 questions. Each question carries 16 marks. There should be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The Final mark for the course is sum of the CIE and SEE Marks.

Semester:III			
Mechanical Unit Operations Laboratory			
Course Code:	MVJ25CHL36	CIE Marks:	50
L: T:P:S	0:0:28:02	SEE Marks:	50
Credits:	1	Total:	100
Hours:	30	SEE Duration:	3 Hrs.
Course Objectives: This course will give ability to: • Enable students to determine physical properties of solids, such as average particle size, shape, sphericity, and density. • Evaluate the performance of crushing and grinding equipment • Measure the effectiveness and efficiency of various separation techniques, including screening, sedimentation, and centrifugal separation in cyclones. • Investigate the principles of fluidization and hindered settling to understand how particles behave in fluid mediums. • Determine specific cake resistance and filter medium resistance using industrial-scale filters like the Plate and Frame Filter Press.			
Guidelines/ Specific Requirements, if any:			
Syllabus			
Experimental study of particle size analysis, screen effectiveness, crushing and grinding operations using jaw crushers, ball mills and drop-weight crushers. Laboratory exercises include sedimentation, determination of settling velocity, thickener design, filtration using leaf filters and plate-and-frame filter presses, determination of specific cake resistance, grindability index measurement, froth flotation studies, cyclone separator performance evaluation and other experiments related to industrial mechanical operations and solid-particle processing			
Sl. No.	Experiments List		
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:

At the end of the course, the student 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.

CO-PO Mapping

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

High-3: Medium-2: Low-1

Evaluation Method**Continuous Internal Evaluation (CIE):**

- **Weekly Evaluation for 30 Marks:** Weekly evaluation should be conducted for every experiment. Marks of each evaluation includes Preparedness / Observation (6 Marks) + Experiment Conduction/ Execution (9 Marks) + Viva Voce (9 Marks) +Record Book (6 Marks)for each experiment. All weekly marks are added and scaled to 30 marks (A).
- Two CIE tests for 20 Marks each should be conducted and averaged to 20 Marks. The student should score minimum 30% in the average test marks (i.e. 6 marks) to avoid NSSR. (B).

Final CIE Marks of practical should be calculated as A+B for 50 marks.

Semester End Examination (SEE):

The SEE of practical is evaluated for 50 marks, distributed as follows:

- Experiment Conduction with Results: 40 marks
- Viva Voce: 10 marks
- Total 50 marks

The Final mark for the course is the sum of CIE and SEE Marks.

Semester:III			
Sustainable Engineering and SDG's			
Course Code:	MVJ25AECK37	CIE Marks:	50
L:T:P:S	14:0:0:16	SEE Marks:	50
Credits:	1	Total:	100
Hours:	30	SEE Duration:	3 Hrs.
Course Objectives: This course will give ability to: • Explain the basic concepts of sustainability, sustainable development and the role of engineers. • Describe the 17 Sustainable Development Goals (SDGs) and relate selected SDGs to engineering disciplines. • Explain basic sustainable-engineering principles including resource efficiency, systems thinking, life-cycle thinking and circular economy. • Identify environmental, social and economic impacts associated with engineering products, processes and services. • Apply simple sustainability thinking to propose an improved solution to a real-life engineering problem.			
Syllabus			
Concepts of sustainability, sustainable development, environmental, social and economic dimensions of engineering, and the United Nations Sustainable Development Goals (SDGs). Topics include environmental pollution, waste management, climate change, greenhouse effect, ozone depletion, carbon footprint, carbon credits and environmental legislation. The syllabus covers environmental management systems, life cycle analysis, circular economy, industrial ecology, renewable and non-renewable energy resources, sustainable habitat design, green engineering, sustainable urbanization, energy-efficient technologies and practical approaches for developing sustainable engineering solutions			
Module I			
Foundations of Sustainability and Role of Engineers: Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs)-Overview of the 17 SDGs, Clean Development Mechanism (CDM), Introduction to the UN 2030 Agenda.			3 Hrs
Module II			
Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.			3 Hrs
Module III			
Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Sustainable Engineering Principles and Circular Economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.			3 Hrs
Module IV			
Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, Environmental footprints, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.			3 Hrs

Module V	
Sustainable design and practices/Case Studies/Student Activity: Sustainability practices: Basic concept of sustainable habitat, conventional design Vs sustainable design, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.	2 Hrs
Textbooks: 1. ToolseeramRamjeawon, Introduction to Sustainability for Engineers, CRC Press, 1st Edition, 2020. 2. Rag, R. L. and Ramesh Lakshmi Dinachandran, Introduction to Sustainable Engineering, PHI Learning. 3. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall. 4. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning 5. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.	
Reference Books: 1. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System 2. Environment Impact Assessment Guidelines, Notification of Government of India, 2006 3. Allenby, B. R., The Sustainability Engineering Handbook, McGraw-Hill. 4. Mihelcic, J. R. and Zimmerman, J. B., Environmental Engineering: Fundamentals, Sustainability, Design, Wiley. 5. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998 6. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS). 7. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication	
Course Outcomes: At the end of the course, the student will be able to: CO1: Explain sustainability, sustainable development and the role of engineers CO2: Explain different types of environmental pollution problems, SDGs, relate them to engineering applications, and their sustainable solutions CO3: Explain life-cycle thinking and environmental footprints CO4: Apply basic principles of sustainable engineering and circular economy CO5: Propose a basic sustainable engineering solution to a real-life problem	

CO-PO Mapping

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

High-3: Medium-2: Low-1

Evaluation Method

Continuous Internal Evaluation (CIE) – 50 Marks

The CIE for the mandatory credit courses common across all disciplines comprises of two components as follows:

Internal Assessment Tests (30 Marks):

Two Internal Assessment tests will be conducted, each comprising 50 multiple choice questions for a total of 50 marks. The average of the two test scores will be scaled down to 30 marks.

Assignments (20 Marks):

Students are required to complete two assignments, each carrying 10 marks. These assignments may include projects*, poster presentations*, seminars*, or similar academic activities. The marks of the two assignments are added to get 20 marks.

*Each assignment will undergo two rounds of evaluation to assess progress and quality

At the beginning of the semester, the instructor/faculty teaching the course has to announce the methods of Assignment for the course.

Together, these two components are added to get the Final CIE marks of 50.

Semester End Examination (SEE) – 50 Marks

A Semester End Examination is conducted for 50 marks comprising of multiple-choice questions (MCQ) type each of one mark.

The final score for the course out of 100 is the SumTotal of SEE and CIE.

Semester:III			
Computing Techniques Lab			
Course Code:	MVJ25CH38SL	CIE Marks:	50
L: T:P:S	0:0:28:02	SEE Marks:	50
Credits:	1	Total:	100
Hours:	30	SEE Duration:	3 Hrs.
Course Objectives: This course will give ability to: - Understand the specified problems for developing a program for problem solving in engineering contexts - Select appropriate software tool for developing innovative program for problem solving in Chemical Engineering - Apply numerical methods for solving complex problems and to determine plausible solutions for data analysis - Analyse the program results for getting cognitive insights and augmenting visualization as well as analysis capabilities			
Guidelines/ Specific Requirements, if any:			
Syllabus			
Development of computer programs for chemical engineering applications involving reaction kinetics, ideal gas calculations, Newton’s law of cooling, fluid flow analysis, mass balance calculations, chemical reaction equilibrium and vapor-liquid equilibrium. Practical exercises focus on numerical methods, data handling, visualization techniques, engineering computations, modelling of process systems, analysis of engineering data and interpretation of computational results using appropriate software tools			
Sl. No.	Programming themes		
1.	Arrhenius mass action kinetics law for determining kinetic constant is a function of reaction temperature		
2.	Ideal gas law for finding density and specific volume of air		
3.	Newton’s law of cooling – Coffee temperature in a cup		
4.	Laminar flow of liquids in a tiny pipe		
5.	Table salt mass calculation		
6.	Aspirin composition from molecular formula		
7.	Newton’s second law of motion		
8.	Data handling and visualization using diverse software tools		
9	Mass balances calculation with recycle stream		
10	Chemical reaction equilibria calculation		
11	Vapor-liquid equilibria calculation		
Programming for all problems must be conducted if feasible. Otherwise, minimum of 8 programs must be attempted			

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Developing a program for problem solving in engineering contexts via formal understanding of specified problem

CO2: Creating innovative program for problem solving in Chemical Engineering by appropriate selection of tools

CO3: Determining plausible solutions for data analysis by applying numerical methods appropriately to solve complex problems and

CO4: Augmenting visualization as well as analysis capabilities by analysing the program results for getting cognitive insights

CO-PO Mapping

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

High-3: Medium-2: Low-1

Evaluation Method**Continuous Internal Evaluation (CIE):**

- **Weekly Evaluation for 30 Marks:** Weekly evaluation should be conducted for every experiment. Marks of each evaluation includes Preparedness / Observation (6 Marks) + Experiment Conduction/ Execution (9 Marks) + Viva Voce (9 Marks) +Record Book (6 Marks)for each experiment. All weekly marks are added and scaled to 30 marks (A).
- Two CIE tests for 20 Marks each should be conducted and averaged to 20 Marks. The student should score minimum 30% in the average test marks (i.e. 6 marks) to avoid NSSR. (B).

Final CIE Marks of practical should be calculated as A+B for 50 marks.

Semester End Examination (SEE):

The SEE of practical is evaluated for 50 marks, distributed as follows:

- Experiment Conduction with Results: 40 marks
- Viva Voce: 10 marks
- Total 50 marks

The Final mark for the course is the sum of CIE and SEE Marks.

SEMESTER III		
PHYSICAL EDUCATION (SPORTS & ATHLETICS)		
Course Code:	MVJ25PE39	CIE Marks: 100
L: T:P:S	0:0:0:28	SEE Marks: -
Credits:	0	Total :100
Hours:	28	SEE Duration: -
Course Objectives: the student will be able to		
1	Understand the meaning and importance of the fitness and the benefits of fitness	
2	Types of fitness and fitness tips.	
3	Importance of Sports, and Yoga in a day-to-day life.	
4	Understand the importance of aerobics and other activities for healthy lifestyle.	
5	Know about the different roles of organization and administration in sports events.	
Topics / Activities to be Covered (100Marks)		
Module I		5Hours
Orientation ➤ Lifestyle ➤ Fitness ➤ Food & Nutrition: Sports diet. ➤ Stress Management		
Module II		5 Hours
General Fitness & Components of Fitness ➤ Warming up (Free Hand Exercises). ➤ Strength—Push-up/Pull-ups ➤ Speed—30MtrDash. ➤ Agility—Shuttle Run ➤ Flexibility—Sit and Reach		
Module III		6 Hours
Specific Games (Anyone to be selected by the student) ➤ Volleyball— Attack, Block, Service, Upper Hand Pass and Lower Hand and Pass. ➤ Throw ball—Service, Receive, Spin attack, Net Drop & Jump throw. ➤ Kabaddi— Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus. ➤ Basketball-dribbling, passing, shooting etc. ➤ Table Tennis—Service (Fore Hand & Back Hand) ➤ Receive (Fore Hand & Back Hand) ➤ Smash, Athletics (Track / Field Events) -Running, Jumping, Throwing.		

Module IV		6 Hours
Role of Organization and administration		
➤ Planning. ➤ Organizing. ➤ Staffing. ➤ Directing. ➤ Coordinating & controlling. ➤ Reporting & Recording. ➤ Budgeting.		
Module V		6Hours
Aerobics		
➤ Dance Aerobics ➤ Sport Aerobics ➤ Warm up Aerobics ➤ Cardiovascular Aerobics		
Course Outcomes: After completing the course, the students will be able to		
CO1	Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness.	
CO2	Familiarization of health-related Exercises, Sports for overall growth and development.	
CO3	Create a foundation for the professionals in physical Education and Sports.	
CO4	Participate in the competition at regional / state / national / international levels.	
CO5	Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.	
Assessment Details for CIE (both CIE and SEE)		
Weight age	CIE – 100%	• Implementation strategies of the project (PE work). • The last report should be signed by PED, the HOD and principal. • At last report should be evaluated by the PED of the institute. • Finally, the consolidated marks sheet should be sent to the Controller of Examinations office.
Participation of student in all the modules	50 Marks	
Final presentation / exhibition / Participation In competitions / practical on specific tasks Assigned to the students	50 Marks	
Total marks for the course in each semester	100 Marks	
Marks scored for 100 by the students should be Scale to 50 marks in each semester.		
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.		

CO/PO Mapping											
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1	-	-	-	-	-	-	-	2	2	-	-
CO 2	-	-	-	-	-	-	-	2	2	-	-
CO 3	-	-	-	-	-	-	-	2	2	-	-
CO 4	-	-	-	-	-	-	-	2	2	-	-
CO 5	-	-	-	-	-	-	-	3	3	-	-

Semester: III		
Yoga		
Course Code:	MVJ25YO39	CIE Marks: 100
L: T:P:S	0:0:0:28	SEE Marks: -----
Credits:	0	Total :100
Hours:	28	SEE Duration: -----
Course Learning Objectives: The students will be able to		
1	Promote Holistic Wellness Practice in Students.	
2	Develop Physical Awareness and Flexibility	
3	Improve Focus and Academic Performance	
4	Encourage Healthy Lifestyle Habits.	
5	Support mental Health and Emotional balance.	
<u>The Health Benefits of Yoga:</u>		
1)Yoga helps with a person-centered approach to well-being offering physical, mental(cognitive), and spiritual(emotional) benefits for students. These benefits can help students cope with the demands of academic journeys, improve their overall health and promote personal development.		
• Key Benefits of Various Yoga Techniques: • Enhances Physical Well-being. • Boosts Mental Focus. • Promotes Emotional Stability. • Reduces Stress Levels. • Encourages Inner Growth.		
It is also used as an adjunct therapy to support recovery from various physical health conditions such as:		
• Chronic Pain. • Back Pain. • Arthritis. • Cardiovascular Diseases. • Asthma. • Chronic Fatigue Syndrome. • Menstrual Disorders. • Digestive Issues. • Thyroid Imbalances. • Migraine and headache.		

2) Core observations on how yoga functions as a complementary mind-body intervention to support the psychological, physiological and spiritual healing processes associated with various health conditions.

Psychological Benefits:

- Stress reduction.
- Anxiety relief.
- Trauma healing.
- Cognitive and clarity focus.
- Emotional Regulation.
- Aid in managing depression.

Physiological Benefits:

- Enhance Blood Circulation.
- Boost Cardiovascular Health.
- Supports Overall Gut Function.
- Promotes Thyroid Function.
- Relief from Headaches.
- Increased Energy level.

Spiritual Benefits:

- Cultivating gratitude and Compassion
- Self –realization
- Balance and Harmony
- Inner Peace
- Sense of oneness.
- Mindfulness

MODULE- I

Discipline and Awareness Reflect Habits s Thoughts:

- **Basic theory of Yoga, Yamas s Niyamas**
Yoga definition, Aims and Objectives, importance of yoga in students.
- **Introduction to Yoga asana**
Yoga asana meaning, principle and health benefits.
- **Ashtanga yoga**
Meaning, breathing techniques.
- **Four paths of yoga**
Karma yoga, Bhakthi yoga, Raja yoga, Jnana yoga.
- **Surya namaskar**
Surya namaskar prayer and its meaning, benefits and importance.
- **Yoga asanas**
Asanas it's need, importance, name and technique.

**7
Hrs**

Sitting: -Vajrasana, - adasana, Ardachakrasana, Prone line: -Advasana, Bhujangasana Supine line: -Shavasana, Supta baddhakonasana, Balancing posture: -Vrikshasana, Garudasana	
MODULE -II	
Building strength and focus Finding out the obstacle: • Kriya Yoga Tapas, Svadhyaya, Ishwarapranidhana • Five Kleshas Obstacles. • Pranayama Introduction to Pranayama. • Pratyahara Preparing mind for meditation, Breathe focus techniques. • Yoga asanas Standing: -Virabhadrasana, Parshvakona Sitting: -Vajrasana, Paschimottanasana Prone Line: -Dhanurasana, Shalabhasana, Supine Line: -Ananda Balasana, Supta Matsyendrasana , Balancing: -Natarajasana (Dancer Pose)	7 Hrs
MODULE -III	
Awareness and inner balance: Finding how focused is the mind • Dharana: Concentration • Dhyana: Meditation • Swasthya, Smriti, Sankalpa. Tool of academic excellence. • Samyama Patanjali's concept of samyama • Yogasanas Standing: - ArdhaChandrasana, Utkatasana Sitting: - Padmasana (or prep), Gomukhasana Prone Line: - Adho Mukha Svanasana, Naukasana Supine Line: - SuptaBaddhaKonasana, Chakrasana Balancing: - Garudasana (Eagle Pose)	7 Hrs
MODULE -IV	

Integrating Yoga in daily Life: • Yama niyama Acharam: Practice of ethical Discipline (practicing nonviolence, truth, cleanliness) • Ahara- Vihara Samyama: Practice discipline in diet & lifestyle. • Asana- pranayama sadhana: Daily practice of asanas and pranayama • Yogasanas: Standing: -PrasaritaPadottanasana, ParivrttaTrikonasana Sitting: -Baddha Konasana, Marichyasana Prone Line: -Ustrasana (Camel), Makarasana (relaxation) Supine Line: -Sarvangasana, Shavasana Balancing: - Bakasana (Crow – optional or modified)	7 Hrs
--	-------

Course outcomes	
CO1	Identify and reflect on personal habits and thoughts.
CO2	Explain the basic theory of Yoga, including Yamas & Niyama.
CO3	Understand the definition, aims, objectives, and importance of Yoga, especially for students.
CO4	Enhance physical and mental strength through advanced Yoga asanas.

CO/PO Mapping											
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1		2						3	2	2	
CO 2	2						2	2			
CO 3	2					2	2	3			
CO 4					2		3	3			

Weekly assessment will be done by the instructor by giving different poses / Asanas.

The final assessment scaled up to 100 marks.

Text Book

1	Ajitkumar, "Yogapravesha in Kannada"
2	BKS Iyengar "Light on Yoga"

Reference Books

1	M L Gharote & Dr. S K Ganguly, "Teaching Methods for Yogic practices"
2	Yoga Instructor Course hand book published by SVYASA University, Bengaluru
3	Yamini Muthanna, "Yoga for Children –step by step"

Semester:III			
Additional Mathematics-I (Common to all branches)			
Course Code:	MVJ25MATDIP310	CIE Marks:	100
L: T:P:S	28:0:0:0	SEE Marks:	0
Credits:	0	Total:	100
Hours:	28		
Course Objectives: This course will give ability to: To familiarize the important and introductory concepts of Differential calculus, Integral calculus, Vector differentiation, Probability, ordinary differential equations of first order, and analyze the engineering problems.			
Syllabus			
Differential calculus-nth derivative, Leibnitz theorem, Polar curves - angle between the radius vector and tangent, angle between two curvespedal equation,Taylor’s and Maclaurin’s series expansions, Integral Calculus: Statement of reduction formulae for the integrals of of $\sin^n(x)$, $\cos^n(x)$, $\sin^n x$, $\cos^m x$, Evaluation of these integrals with standard limits-problems, Double -Simple examples, Triple integrals, Vector Differentiation: Differentiation of vector functions, Velocity and acceleration of a particle moving on a space curve Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields, Vectoridentities $-\text{div}(\phi \vec{A})$, $\text{curl}(\phi \vec{A})$, $\text{curl}(\text{grad}(\phi))$, $\text{div}(\text{curl} \vec{A})$, Probability: Basic terminology, Sample space and events, Axioms of probability. Addition and multiplication theorems, Conditional probability, Bayes theorem, Introduction – Formation of differential equation, solutions of first order and first-degree differential equations, Variable separable form, homogeneousExact, linear differential equations, Clairaut’s equation.			
Course Plan			
Module I			
Differential calculus			
Sr.No	Topics to be covered		Hours required
1	Differential calculus: Recapitulation of successive differentiation -nth derivative		6 Hrs
2	Leibnitz theorem (without proof) and Problems		

3	Polar curves - angle between the radius vector and tangent, angle between two curves	
4	pedal equation	
5	Taylor’s and Maclaurin’s series expansions- Illustrative examples	
Module II		
Integral Calculus		
Sr. No	Topics to be covered	Hours required
1	Integral Calculus: Statement of reduction formulae for the integrals of $\sin^n(x)$, $\cos^n(x)$, $\sin^n x$, $\cos^n x$	6 Hr
2	Evaluation of these integrals with standard limits-problems	
3	Double -Simple examples	
4	Triple integrals-Simple examples	
Module III		
Vector Differentiation		
Sr. No	Topics to be covered	Hours required
1	Vector Differentiation: Differentiation of vector functions	6 Hr
2	Velocity and acceleration of a particle moving on a space curve	
3	Scalar and Vector point functions, Gradient, Divergence, Curl	
4	Solenoidal and Irrotational vector fields	
5	Vector identities $-\text{div}(\phi \vec{A}), \text{curl}(\phi \vec{A}), \text{curl}(\text{grad}(\phi)), \text{div}(\text{curl} \vec{A})$.	
Module IV		
Probability		
Sr. No	Topics to be covered	Hours required
1	Probability:Basic terminology, Sample space and events	5 Hr
2	Axioms of probability. Addition and multiplication theorems	
3	Conditional probability – illustrative examples	
4	Bayes theorem-examples	

Module V		
Ordinary Differential Equations of First Order		
Sr. No	Topics to be covered	Hours required
1	Introduction – Formation of differential equation, solutions of first order and first degree differential equations	5 Hr
2	Variable separable form, homogeneous	
3	Exact, linear differential equations	
4	Some special first order equations: Clairaut’s equation	
5	Some special first order equations: Clairaut’s equation	
Textbooks: 1. B.S. Grewal, “Higher Engineering Mathematics” Khanna Publishers, 43rd Edition, 2013.. 2. Ramana B. V., “Higher Engineering Mathematics”, Tata Mc Graw-Hill, 2006.		
Reference Books: 1. Erwin Kreyszig, “Advanced Engineering Mathematics”, Wiley-India publishers, 10th edition,2014. 2. G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19		
Other References:(NPTEL/SWAYAM. Any Other) 1. https://youtube.com/playlist?list=PL7oBzLzHZ1wXBSiJEgqz_iwVoLiY8qhbv&si=LWY0G3ywwomMbHN9G NPTEL course: Mechanics of Materials by Dr. U Saravanan, IIT Madras. 2. https://youtu.be/rveuCHNkaC4?si=jIJomstkFZySE0tk Mechanics of Solids by Prof. Priyanka Ghosh, IIT Kanpur. 3. https://youtu.be/U-5tA9ZMsno?si=Wcl7W7JN3Wmg3McP 4. https://youtu.be/COI0BUmNHT8?si=77D82b9BAnf-jVT2 5. https://youtu.be/ES741wq3APA?si=iqR2QZ5xreoVGo1v		
Course Outcomes: At the end of the course, the student 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

CO-PO Mapping:

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

High-3: Medium-2: Low-1:

Evaluation Method:

Continuous Internal Evaluation (CIE):

- Two CIE Will be conducted for 50 marks each and average of two will be taken (A)
- Alternative Assessment Tools (AAT) should be a project / Quiz/ Seminar cum Presentation / other suitable alternate assessment methods for 30 marks. Two evaluations will be conducted (**B**)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C) for 100 marks