COLLEGE OF ENGINEERING
Since 1982
Engineering A Better Tomorrow
An Autonomous Institution

Bachelor of Engineering in Chemical Engineering

Scheme and Syllabus
(2025 Scheme)

III Semester

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	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	SL						
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	Physical Education (PE) (Sports and Athletics)	0	0	0	28	28	---	100	---	100	PP
		MVJ25YO39	Yoga										
10	NCMC	MVJ25MATDIP310	Additional Mathematics – I*	14	0	0	14	28	----	100	---	100	PP
TOTAL													**22**

***Applicable for Lateral entry students only**

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Semester – IV

Sl. No	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIE Marks	SEE Marks	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*	14	0	0	14	28	---	100	---	100	PP
TOTAL													**20**

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Semester – V

Sl. No	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIE Marks	SEE 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

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Semester – VI

Sl. No	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	SL						
1	IPCC	MVJ25CH61	Process Control & Industrial IoT	42	0	28	50	120	3	50	50	100	4
2	PCC	MVJ25CH62	Process and Industry Safety	42	0	0	48	90	3	50	50	100	3
3	PCC	MVJ25CH63	Heterogeneous Reaction Systems	42	0	0	48	90	3	50	50	100	3
4	PCC	MVJ25CH64	Chemical Process Equipment Design	56	0	0	64	120	3	50	50	100	4
5	PEC	MVJ25CH65X	Professional Elective Courses-II	42	0	0	48	90	3	50	50	100	3
6	PCCL	MVJ25CHL66	Computer Aided Design and Drawing Lab	0	0	28	2	30	3	50	50	100	1
7	AEC	MVJ25AECK67	Ability Enhancement Course	14	0	0	16	30	2	50	50	100	1
8	SDL	MVJ25CH68SL	Design of Experiments Lab	0	0	28	2	30	3	50	50	100	1
9	SDC	MVJ25EA69	Capstone Project – Phase 1	0	0	0	90	90	3	100	--	100	3
10	NCMC	MVJ25UHV610	Universal Human Value	14	0	0	14	28	---	100	---	100	PP
TOTAL													**23**

Professional Elective Course-II

MVJ25CH65A	Pharmaceutical Technology	MVJ25CH65C	Petrochemicals
MVJ25CH65B	Food Technology	MVJ25CH65D	Pollution Control and Safety

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Semester – VII (Swappable VII and VIII SEMESTER) (SCHEME-A)

Sl. No	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	L						
1	IPCC	MVJ25CH71	AI Enhanced Chemical Process Modelling & Simulation	42	0	28	50	120	3	50	50	100	4
2	PEC	MVJ25CH72X	Professional Elective Course-III	42	0	0	48	90	3	50	50	100	3
3	PEC	MVJ25CH73X	Professional Elective Course -IV	42	0	0	48	90	3	50	50	100	3
4	OEC	MVJ25xx74X	Open Elective Course-I	42	0	0	48	90	3	50	50	100	3
5	SDC	MVJ25EA75	Capstone Project - Phase-II	0	0	0	210	210	3	100	100	200	7
6	NCMC	MVJ25IKS76	Indian Knowledge System	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**

Professional Elective Course-III			
MVJ25CH72A	Transport Phenomena	MVJ25CH72C	Process Analytical Technology
MVJ25CH72B	Process Intensification	MVJ25CH72D	Environmental Remediation
Professional Elective Course-IV			
MVJ25CH73A	Chemical Process Integration	MVJ25CH73C	Biofuels
MVJ25CH73B	Biochemical Engineering	MVJ25CH73D	Polymer Technology
Open Elective Course-I			
MVJ25CH74A	Sustainable Energy Technology	MVJ25CH74C	Computational Fluid Dynamics
MVJ25CH74B	Food Technology	MVJ25XX74D	**Foreign Language** (NPTEL/SWAYAM/online VTU)

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Semester – VIII (Swappable VII and VIII SEMESTER) (SCHEME-A)

Sl. No.	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	SL						
1	PEC	MVJ25CH81X	Professional Elective-V (NPTEL/VTU Online Course)	42	0	0	48	90	3	50	50	100	3
2	OEC	MVJ2CH82X	Open Elective-II (NPTEL/VTU Online Course)	42	0	0	48	90	3	50	50	100	3
3	SDC	MVJ25INT83X	Internship (15 weeks or 90 working days)	--	--	--	--	360	3	100	100	200	9
TOTAL													**15**

Professional Elective-V

MVJ25CH81A	NPTEL/VTU Online Course	MVJ25CH81C	NPTEL/VTU Online Course
MVJ25CH81B	NPTEL/VTU Online Course	MVJ25CH81D	NPTEL/VTU Online Course

Open Elective-II

MVJ25CH82A	NPTEL/VTU Online Course	MVJ25CH82C	NPTEL/VTU Online Course
MVJ25CH82B	NPTEL/VTU Online Course	MVJ25CH82D	NPTEL/VTU Online Course

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 Internship**: Shall be opted by students unable to secure internships, offering credit equivalence through curated online courses available at http:// www.online.vtu.ac.in

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VII and VIII semesters for the candidates who opt for a two-semesters internship along with Capstone Project (Scheme B)

Sl. No.	Course	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	# TH / S	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				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	Professional Elective Course-III (NPTEL/VTU Online Course)	42	0	0	48	90	--	50	50	100	3
3	PEC	MVJ25CH73X	Professional Elective Course-IV (NPTEL/VTU Online Course)	42	0	0	48	90	--	50	50	100	3
4	OEC	MVJ25CH74X	Open Elective Course -I (NPTEL/VTU Online course)	42	0	0	48	90	---	50	50	100	3
5	SDC	MVJ25CH75	Capstone Project - Phase-II	0	0	0	210	210	3	100	100	200	7
6	NCMC	MVJ25IKS76	Indian Knowledge System	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	Professional Elective-V (NPTEL/VTU Online Course)	42	0	0	48	90	---	50	50	100	3
2	OEC	MVJ25CH82X	Open Elective-II (NPTEL/VTU Online Course)	42	0	0	48	90	---	50	50	100	3
3	SDC	MVJ25INT83X	Internship (Two- semester internship for a minimum Period of 180 working days or -30 weeks)	--	--	--	--	360	3	50	50	100	9
	Total												**15**
	VII semester and VIII semester Credits Total												**37**

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

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

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 internships 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 (56 HOURS THEORY + 64 hours self-study)	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, *Higher Engineering Mathematics*, Khanna Publishers, 45th Edition, 2023.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers & Keying Ye, *Probability and* Statistics for Engineers and Scientists, Pearson, 10th Edition, 2018.
3. T. Veerarajan, *Probability, Statistics and Random Processes*, 3rd Edition, 2016, McGraw Hill Education.
4. A. M. Haghighi, I. Wickramasinghe, E. A. Appiah, *Probability, Statistics, and Stochastic Processes for Engineers and Scientists*, 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=GPImZMvCHNdMoGoS
3 https://youtu.be/Q0z4YKfrlMM?si=YQersroRgW5R7nCW
4 https://youtu.be/n9qpktdFfLU?si=9OJPAlaUdK-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

The syllabus introduces the properties of fluids. It covers fluid statics and properties, differential and integral balance equations (Bernoulli, Navier-Stokes), laminar/turbulent pipe flow with friction losses, and external flow or transportation machinery concepts of drag coefficient, fluidization

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, 5thedition,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

The syllabus covers fundamental chemical process calculations including units and dimensions, mole and concentration concepts, gas laws and mixtures, steady-state material balances for non-reactive and reactive systems, stoichiometry, combustion, recycle, bypass and purge operations, energy balances and thermochemistry including heat effects and adiabatic flame temperatures, and unsteady-state material and energy balances with basic analytical and numerical methods for transient process analysis..

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.	
8	Detailed calculations involving distillation, absorption, extraction, drying and crystallisation (are excluded to avoid duplication with subsequent Mass Transfer and Unit Operations courses)	

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	11-Hrs
2	Unsteady-state material balances for filling and emptying tanks, mixing and dilution, batch and semi-batch systems.	
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. Hougen, 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

The unit operations are very essentially part of the chemical engineering; and hence, basic knowledge about the principles and equipment of solid-solid unit operations and solid-liquid unit operations is mandatory for any professional chemical engineer. The syllabus coverts the concepts of particle technology, Laws of Size reduction, Various size reduction apparatus, filtration equipments. It also covers the brief knowledge of mixing and agitation.

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",7th 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

The syllabus covers introduction to programming via various tools such as Excel, Matlab, Scilab, Python, Pandas, Seaborn, Scikit-learn and so on. It also deepens the knowledge on data handling and visualization via tools including introduction to Machine Learning. It considers the applications of Numerical Methods in Chemical Engineering problem solving and to determine plausible solutions to complex engineering problems via case-studies.

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". 2nd 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:

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	
Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.	
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	3 Hrs

energy.	
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. Toolseeram Ramjeawon, 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:

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%	
Participation of student in all the modules	50 Marks	• 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.
Final presentation / exhibition / Participation In competitions / practical on specific tasks Assigned to the students	50 Marks	
Total marks for the course in eachsemester	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.

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CO/PO Mapping											
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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, Ardhachakrasana, **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, Smrithi, 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:	7 Hrs
• Yama niyama Acharam: Practice of ethical Discipline (practicing nonviolence, truth, cleanliness) • Ahara- Vihara Samyama: Practice discipline in diet C 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)	

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

Weekley 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"

Weekley 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"
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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	14:0:0:14	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 curves pedal 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, Vector identities - $div(\emptyset\,\vec{A})$, $curl(\emptyset\,\vec{A})$, $curl(grad(\emptyset))$, $div(curl\,\vec{A})$, 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, homogeneous Exact, linear differential equations, Clairaut's equation.

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 $\sin^n(x)$, $\cos^n(x), \sin^n x, \cos^m x$	**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 - $div(\emptyset\,\vec{A})$, $curl(\emptyset\,\vec{A})$, $curl(grad(\emptyset))$, $div(curl\,\vec{A})$.	

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=LWY0G3ywwoMbHN9G 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