Course Title	**COMPLEX ANALYSIS, PROBABILITY AND SAMPLING THEORY**	**Semester**	IV
Course Code	MVJ20MCH41	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 20: 20 : 0	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	3	**Exam. Duration**	3 Hours

Course Objective is to:

The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.

Module-1	**RBT Levels: L1, L2, L3**	**8 Hours**

Complex Variables-I: Review of a function of a complex variable, limits, continuity, and differentiability. Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral theorem. Conformal transformations-Discussion of transformations: $w=z^2$, $w=e^z$, $w=z+(1\ z)(z\neq 0)$.

Applications: It is useful in many branches of mathematics, including algebraic geometry, applied mathematics; including the branches of hydrodynamics, thermodynamics, and particularly quantum mechanics.

Video link / Additional online information (related to module if any):

https://www.youtube.com/watch?v=oiK4gTgncww

https://www.youtube.com/watch?v=WJOf4PfoHow

Module-2	**RBT Levels: L1, L2, L3**	**8 Hours**

Statistical Methods: Introduction, Correlation and coefficient of co relation, Regression, line of regression problems. **Curve Fitting:** Curve fitting by the method of least squares-fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$.

Applications: Correlation and Regression is used to see whether two variables are associated, without necessarily inferring a cause-and-effect relationship. Another important application is to estimate the value of one variable corresponding to a particular value of the other variable. Curve Fittings such as parabola and hyperbola are used in architecture to design arches in buildings.

Video link / Additional online information (related to module if any):

https://www.youtube.com/watch?v=xTpHD5WLuoA

https://www.youtube.com/watch?v=fNLeogEjMmM

https://www.youtube.com/watch?v=tl5QNhSe0Yk

Module-3	RBT Levels: L1, L2, L3	8 Hours

Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.

Applications: Few of the application areas include in industries, quality control, in errors correction, medicine, agriculture, engineering, for analysis and interpretations of basic data obtained from experiments.

Video link / Additional online information (related to module if any):

https://www.youtube.com/watch?v=nrkd0IlVxkY

https://www.youtube.com/watch?v=6x1pL9Yov1k

Module-4	RBT Levels: L1, L2, L3	8 Hours

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance. **Stochastic Process:** Probability vector, Stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability – problems.

Applications: Stochastic processes are widely used as mathematical models of systems and phenomena that appear to vary in a random manner.

Video link / Additional online information (related to module if any):

https://www.youtube.com/watch?v=wHRUtNmPjyE

https://www.youtube.com/watch?v=FWe5uk5NA5I

https://www.youtube.com/watch?v=4RnVwa9TG2g

Module-5	RBT Levels: L1, L2, L3	8 Hours

Sampling Theory and Statistical Inference: Sampling, Sampling Distributions, Type I and Type II errors, standard error, Z – test, student's t- distribution, test of hypothesis for means, test for hypothesis for proportions, confidence limits for means, Chi-square distribution as a test of goodness of fit.

Applications: A large number of analyses for process control, product quality control for consumer safety, and environmental control purposes are using Sampling Theory.

Video link / Additional online information (related to module if any):

https://www.youtube.com/watch?v=zmyh7nCjmsg

https://www.youtube.com/watch?v=fuBvQJP0ecw&list=PLp6ek2hDcoNCp9o8aLQrbY15a-

o0weoTd&index=2 https://www.youtube.com/watch?v=tFRXsngz4UQ https://www.youtube.com/watch?v=Q1yu6TQZ79w	
Course outcomes:	
CO1	State and prove Cauchy - Riemann equation with its consequences and demonstrate Con-formal Transformation.
CO2	Illustrate Complex Integration using Cauchy's Integral theorem, Cauchy's Integral formula and Cauchy's Residue theorem.
CO3	Use Method of Least Square for appropriate Curves. And Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.
CO4	Develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, information theory and design engineering
CO5	Demonstrate testing of hypothesis of sampling distributions and illustrate examples related to discrete parameters.

Text Books:	
1	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition 2013.
2	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition,2014.
Reference Books:	
1	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
2	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition
3	Jain R. K.& IyengarS.R.K., Advanced Engineering Mathematics, Narosa Publishing House, 2002.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (10 marks)

- Assignments (10 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	CHEICAL ENGINEERING THERMO DYNAMICS	Semester	IV
Course Code	MVJ20CH42	CIE	50
Total No. of Contact Hours	50 L:T:P::30:20:0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hours

Course objective is to:

- Learn fundamentals of thermodynamics such as types of properties, processes and laws of thermodynamics for flow and non-flow process.
- Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem-solving skills.
- Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.
- Study the estimation of partial molar properties, property changes of mixing, and ideal and non-ideal solutions.
- Learn the fundamentals of phase equilibrium, concept of chemical potential and chemical reaction equilibrium to find feasibility and extent of conversion for the industrial reactions.

Module-1	RBT Level: L1, L2, L3	10 Hours

Syllabus Content: Basic Concepts: System, Surrounding and processes, Closed and Open systems, state and Properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase rule, Zeroth law of thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes. **First Law Of Thermodynamics:** General statement of First law of thermodynamics, First law for cyclic process and non-flow processes, Heat capacity. **Heat Effects Accompanying Chemical Reactions:** Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction.

Experiential learning: Demonstrate working of bomb calorimeter to understand the fuel heat capacity measurement.

Applications: These concepts are applied to extensive application in chemical engineering. The equilibrium and rate of change can change can be predicted to determine the maximum yield of the chemical processes.

Video Links/Any other special information: https://nptel.ac.in/courses/103101004/		
Module-2	**RBT Level: L1, L2, L3**	**10 Hours**
P-V-T Behaviour: P-V-T behaviour of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases: Vander Waals equation, Redlich – Kwong equation, Peng – Robinson equation, Virial equation, Compressibility charts: Principles of corresponding states, generalized compressibility charts. **Second Law of Thermodynamics:** General statements of the Second law, Concept of Entropy, The Carnot Principle, calculation of entropy changes, Clausius Inequality, Entropy and Irreversibility, Third law of Thermodynamics. **Experiential learning:** (Experiments which can be conducted on the concepts of contents) Explain the concept of entropy with simple reaction **Applications:** Application of first law and second law of thermodynamics for fluid flow problems. Estimation the behaviour of real fluids using various equation of state and degree of randomness. **Video Links/Any other special information:** https://www.cpalms.org/Public/PreviewResourceLesson/Preview/75658		
Module-3	**RBT Level: L1, L2, L3**	**10 Hours**
Thermodynamic Properties of Pure Fluids: Reference Properties, Energy Properties, Derived Properties, Work function, Gibbs free energy, Relationships among thermodynamic properties, Exact differential equations, Fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Modified equations for U & H, Effect of temperature on U, H & S, Relationships between CP & CV, Gibbs- Helmholtz equation, Fugacity, Fugacity coefficient, Effect of temperature and pressure on Fugacity, Determination of Fugacity of pure gases, Fugacity of solids and liquids, Activity, Effect of temperature and pressure on activity. **Applications:** Evaluation of the thermodynamic properties of pure fluids using measurable quantities like the pressure-Volume temperature relationship. **Video Links/Any other special information:** https://nptel.ac.in/content/storage2/courses/103101004/downloads/chapter-5.pdf		
Module-4	**RBT Level: L1, L2, L3**	**10 Hours**
Properties Of Solutions: Partial molar properties, Chemical potential, Fugacity in solutions, Henry's law and dilute solutions, activity in solutions, Activity coefficients, Property changes of mixing, excess properties.		

Experiential learning: Determination of partial molar volume for different compositions of ethanol –water system.

Applications: Partial molar properties are useful because chemical mixtures are often maintained at constant temperature and pressure and under these conditions, the value of any extensive property can be obtained from its partial molar property. They are especially useful when considering specific properties of pure substances (that is, properties of one mole of pure substance) and properties of mixing (such as the heat of mixing or entropy of mixing)

Video Links/Any other special information (Papers):

https://www.youtube.com/watch?v=FLRkGbzw0-

Module-5	RBT Level: L1, L2, L3	10 Hours

Phase Equilibria: Criteria of phase Equilibria, Criterion of stability, Duhem's theorem, Vapor – Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, VLE at low pressures, VLE at high pressures, consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem's equation.

Experiential learning: To generate VLE data for a binary mixture of Acetone and Benzene.

Applications: Thermodynamics of chemical reactions predicts the equilibrium conversion attainable in a chemical reaction and the effect of operating conditions on the degree of completion of the reaction.

Video Links/Any other special information:

https://www.chem.uci.edu/~lawm/263%206.pdf

Course outcomes:

CO1	Calculate the heat and work requirements for the given flow or non-flow processes.
CO2	Analyse and find properties such as Pressure, Volume and temperature for equations of states and from the fundamentals of first law of thermodynamics.
CO3	Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
CO4	Differentiate between ideal and non-ideal solution and estimate partial molar properties.
CO5	Identify the role of thermodynamics in the design and operation of chemical reaction system.

Text Books:	
1	Smith, J. M., Van Ness, H. C., & Abbott, M. M. (1987). Introduction to Chemical Engineering Thermodynamics McGraw Hill. *Inc.: New York*.
2	Rao, Y. V. C. (1997). *Chemical engineering thermodynamics*. Universities Press.
Reference Books:	
1	Narayanan, K. V. (2004). *A textbook of chemical engineering thermodynamics*. PHI Learning Pvt. Ltd..
2	**Web Link and Video Lectures:** https://nptel.ac.in/courses/103101004/

Scheme of Evaluation		
Details		**Marks**
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e., ∑ (Marks Obtained in each test)/3	CIE (50)	30
Assignments		10
Seminar		10
Semester End Examination	SEE (50)	50
	Total	100

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

High-3, Medium-2, Low-1

Course Title	CHEMICAL REACTION ENGINEERING-1	Semester	IV
Course Code	MVJ20CH43	CIE	50
Total No. of Contact Hours	40 L : T : P :: 20 : 20 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

- Understand the scope of Chemical reaction Engineering.
- Analyze and interpret the experimental data to determine kinetic rate equation and understand the design of ideal reactor systems.
- Understand the concept of non-isothermal reactors.

Module-1	RBT Level: L1, L2, L3	8 Hours

Introduction to Chemical Reactions. Homogeneous and heterogeneous reactions with their basic definitions, Elementary and non-elementary reactions, reaction rate and rate constant, order and molecularity of a reaction, Temperature dependency of rate constant and kinetic modelling: Arrhenius, collision and transition state theories.

Non-Elementary Reactions: Difference between elementary and non- Elementary reactions. Kinetic models and mechanisms for non- Elementary reactions.

Experiential Learning: Demonstration of Homogeneous and heterogenous reactions and effect of temperature on reaction rate.

Applications: Calculations of reaction rate constants using kinetic theories for a given experimental data.

Video link / Additional online information:

https://nptel.ac.in/courses/103106116/

Module-2	RBT Level: L1, L2, L3	8 Hours

Single Reactions: Interpretation of experimental data using Integral method and differential method, constant volume and variable volume reactions, half-life method. Numerical problems. **Types of reactors:** Batch, Semi-batch, laminar, and mixed flow reactors. Multiphase reactors of Industrial Importance (fixed, fluidized and bubble column reactors) and their practical demonstration.

Experiential Learning: Practical demonstration of fixed-bed, fluidized bed and bubble column reactor types.

Applications: Industrially important reactor types

Video Links/Any other special information:

http://encyclopedia.che.engin.umich.edu/Pages/Reactors/PBR/PBR.html

https://www.youtube.com/watch?v=AzK7K601cAE

Module-3	RBT Level: L1, L2, L3	8 Hours

Design of reactors: Design of Batch, Semi-batch, laminar and mixed flow ideal reactors and their performance equations. Constant volume and variable volume reactors. Design of batch reactor, PFR and MFR. Space time and space velocity, Holding time for flow reactors. Size comparison of ideal reactors. Numerical problems.

Experiential Learning: Virtual demonstration of reaction kinetic studies in batch reactor, PFR and MFR.

Applications: Design of industrial reactors.

Video Links/Any other special information:

http://uorepc-nitk.vlabs.ac.in/#

https://www.youtube.com/watch?v=ftnLJ6VDwS8

Module-4	RBT Level: L1, L2, L3	8 Hours

Multiple Reactor Systems: Plug flow and /or Mixed flow reactors in Series, parallel and series-parallel. Reactors of different types and sizes in series. Design of Reactors for Multiple Reactions: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series- Parallel reactions (Only irreversible reactions must be considered).

Experiential Learning: PFR and MFR in series operation.

Applications: Working and designing of multiple reactor system

Video Links/Any other special information:

https://www.youtube.com/watch?v=puJXBMtB4W4

https://www.youtube.com/watch?v=SVfs9JzMYoc

https://www.youtube.com/watch?v=TleC05u13fI

Module-5	RBT Level: L1, L2, L3	Hours: 8

CHEMICAL REACTION EQUILIBRIUM: Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, Pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, heterogeneous reaction equilibrium, phase rule for reacting systems. **Non-Isothermal Reactors**: Introduction, effect of temperature on equilibrium constant and heat of reaction, Material and Energy balances, conversions in adiabatic and non-adiabatic reactors. **Analysis of Non-Isothermal Reactor**: Design procedure for single reactions, Optimum temperature Progression, Safety concepts for non-isothermal reactors. Numerical problems.

Experiential Learning: To analyze the conversion in an adiabatic reactor. **Applications:** Equilibrium studies on reactive processes help to understand the feasibility and maximum possible yield of the desired product at any given conditions. Non-isothermal reactor systems studies will help to design a reactor and predict conversions under non-isothermal conditions. **Video Links/Any other special information**: https://www.youtube.com/watch?v=WCbnTMBo4Co	
Course outcomes:	
CO1	Explain various types of reactions, factors affecting rate equation, theories for predicting temperature dependency of rate constant and kinetics.
CO2	Interpret experimental data using differential, integral, and half-life methods, and types of chemical reactors with real practise.
CO3	Develop design equations for ideal reactors for constant and variable volume reactions and generating kinetic data in ideal reactors.
CO4	Develop the design of single and multiple reactor systems and reactions.
CO5	Design non isothermal reactors and discuss optimum temperature progression.
Text Books:	
1	Octave Levenspiel. (2004). Chemical Reaction Engineering 3rd edn. ISBN 9780471254.
2	Smith, J. M. (1981). *Chemical engineering kinetics* (No. TP149 S58).
Reference Books:	
1	Fogler, H. S. (2010). *Essentials of Chemical Reaction Engineering: EssentiChemicaReactioEngi*. Pearson Education.
2	**Web Link and Video Lectures:** https://nptel.ac.in/courses/103106116/ http://umich.edu/~elements/5e/lectures/index.html

Scheme of Evaluation:

Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e., ∑ (Marks Obtained in each test)/3	CIE (50)	30
Quizzes - 2Nos.		2X2=4
Assignments (2 Nos.)		5X2=10
Journals/Progress notes		3X2=6
Semester End Examination	SEE (50)	50

Total	100

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	CHEMICAL TECHNOLOGY	Semester	IV
Course Code	MVJ20CH44	CIE	50
Total No. of Contact Hours	40 L : T : P :: 40 : 00 : 00	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

- · Understand the basic concepts of Industrial Processes practiced in different Inorganic & Organic Chemical Industries.
- Get insight into the safety and environmental management schemes practiced.
- Assess different engineering problems of individual processes.
- Understand the plant layout and equipment used in the processes

Module-1	RBT Level: L1, L2, L3	8 Hours

Symbolic Representation of different unit operations and processes to build a flow sheet. **Industrial gases and acids:** Industrial Gases: CO_2, H_2, O_2, N_2, SO_2, SO_3. **Industrial Acids:** Sulphuric, Nitric, Hydrochloric and Phosphoric Acids. **Water:** Introduction, impurities in water, soft water-hard water, causes of hardness, disadvantages of hard water, measurement of hardness, methods of softening of water, purification of water, treatment of boiler feed water. **Soaps and detergents:** Soaps and detergents, theory of detergency.

Experiential Learning:

Estimate Softness and hardness of wastewater by conducting standard analysis.

Applications: Students can estimate the hardness of water and also can evaluate various parameters for checking the quality of water.

Video link / Additional online information:

https://www.youtube.com/watch?v=OiWMSopuuLU

Module-2	RBT Level: L1, L2, L3	8 Hours

Cement industries: Classification, manufacture, reactions, flow diagrams, major and minor engineering problems, applications. **Fermentation industries:** Production of alcohol, Manufacture of beer, wines and liquors. **Oils, fats, waxes:** Vegetable and animal oils and fats. Extraction of vegetable oils, refining of edible oils. Hydrogenation of oils, waxes and their applications.

Experiential learning: Demonstrate an experiment for production of alcohol by

fermentation technology.

Applications:

Production of alcohol, extraction of vegetable oil and chemical processes associated with it can be studied.

Video link / Additional online information:

https://www.youtube.com/watch?v=lcXnWrDZV6Q

Module-3	RBT Level: L1, L2, L3	8 Hours

Chlor-alkali and cement industries: Sodium chloride, Soda ash, Caustic soda, Chlorine. **Cement industries**: Classification, manufacture, reactions, flow diagrams, major and minor engineering problems, applications.

Experiential learning:

To determine the energy required for crushing the sample and working of Ball mills and jaw crushers. Also determine the reduction ration and critical speed of the mill

Applications:

Ball mill and crushers are used in Cement industries for reducing the size of particles.

Video link / Additional online information:

https://www.youtube.com/watch?v=dAD03D5cTF8

Module-4	RBT Level: L1, L2, L3	8 Hours

Petroleum industries and petrochemicals: Origin and classification. Petroleum refining and processing Coal: Formation and Classification of coal, mining of coal, destructive distillation of coal, coking of coal, coal tar distillation, chemicals from coal. **Pulp and Paper Industries:** Raw materials, manufacture of pulp, paper and its major engineering problems.

Experiential learning: Demonstration of various unit operations and processes in production plants.

Applications: Basic concepts of unit operations and processes can be understood which finds applications in treatment and production of paper in industries.

Video link / Additional online information:

https://www.youtube.com/watch?V=e4c3x26dxbm

Module-5	RBT Level: L1, L2, L3	8 Hours

Inorganic fertilizers: Ammonia, urea, ammonium phosphate, ammonium nitrate, ammonium sulphate, DAP, phosphorous pentoxide, super phosphate and triple super phosphate. **Polymers & Rubber:** Macromolecules. Polymerization. PVC, LDPE. Polypropylene. Natural rubber.

Experiential learning: Exhibit the polymerization reactions by conducting experiment with simple monomers. **Applications:** Various types of polymerization can be studied for production of polymers. **Video link / Additional online information:** https://www.youtube.com/watch?v=JIV4ZX1Uh_4	
Course outcomes:	
CO1	Explain the basic processes for manufacture of industrial gases, acids, Soaps and Detergents also sources, impurities and treatment methods of water.
CO2	Get insight of cement manufacture, fermentation products and basic concepts of industrial processes practiced in the manufacture of Oils, Fats, and Waxes.
CO3	Outline the manufacture of Chlor-alkali and Cement industries
CO4	Explain the refining of petroleum, formation, classification of coal, destructive distillation of coal and manufacture of pulp and paper.
CO5	Learn industrial scale operations and processes employed in manufacture of fertilizers & polymers and rubber.

Text Books:	
1	Dryden – Outlines of Chemical Technology for 21st Century, Gopal Rao & Marshall Sittig, 3rd edn. EWP.
2	Shreve's Chemical Process Industries, 4th edn, McGraw Hill.
Reference Books:	
1	Unit Processes in Organic Chemical Industries, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.
2	Encyclopedia of Chemical Technology, Kirk and Othmer, 27th volume, 5th edn, Wiley, 2004.
3	Web Link and Video Lectures: https://swayam.gov.in/nd1_noc19_ch19/preview https://swayam.gov.in/nd1_noc19_cy20/preview https://nptel.ac.in/courses/103107082/ https://nptel.ac.in/courses/103103029/

Scheme of Evaluation		
Details		**Marks**
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e., ∑ (Marks Obtained in each test)/3	**CIE (50)**	**30**
Quizzes - 2Nos.		**2X2=4**
Assignments – 2Nos.		**5X2=10**
Mini Projects/ Case studies - 3Nos.		**3X2=6**
Semester End Examination	**SEE (50)**	**50**
	Total	**100**

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	PROCESS HEAT TRANSFER	Semester	IV
Course Code	MVJ20CH45	CIE	50
Total No. of Contact Hours	40 L:T:P::20:20:0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to:

- Study various modes of Heat transfer and their fundamental relations.
- Study conduction heat transfer and develop mathematical relations for various solid geometries.
- Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
- Study the Boiling phenomenon and to generate pool boiling curve.
- Understand the working and basic design of Heat exchangers
- Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

Module-1	RBT Level: L1, L2, L3	8 Hours

Introduction: Importance of heat transfer in Chemical Engineering operations, Modes of heat transfer. **Conduction:** Fourier's law, Steady state unidirectional heat flow through single and multiphase layers slabs, cylinders and spheres for constant and variable thermal conductivity. - Thermal conductivity measurement-effect of temperature on thermal conductivity, Properties of insulation materials, Types of insulation, Critical and Optimum thickness of insulation, Numerical Problems.

Experiential learning: Determine the thermal resistance of the composite wall and determine the thermal conductivity of each material of the composite wall.

Applications: This kind of composite materials/walls are used in industrial furnaces, air crafts, trains, marines and other thermal engineering applications.

Video Links/Any other special information (Papers):

https://www.youtube.com/watch?v=HbzUeBCmjNQ

Module-2	RBT Level: L1, L2, L3	8 Hours

Extended Surfaces: Types of fins, fin efficiency for longitudinal fins, Fin effectiveness,

Numerical Problems.

Convection: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor, Dimensionless numbers, Dimensional analysis, Empirical correlation for forced and natural convection, Analogy between momentum and heat transfer-Reynold, Colbourn, Prandtl analogies. Numerical Problems.

Experiential learning: Study the heat transfer in extended (finned) tube under natural convection using the experimental set up in heat transfer lab

Applications: Fins are widely used in many applications such as heating, ventilation and air conditioning system, finned tube heat exchangers, solar systems and electrical systems

Video Links/Any other special information:

https://www.youtube.com/watch?v=SNnd0f3xXlg

Module-3	RBT Level: L1, L2, L3	8 Hours

Heat Transfer with Phase Change: Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling, Numerical Problems.

Experiential learning: An experiment to determine the convective heat transfer coefficient in condensation process.

Applications: All chemical industries, thermal and nuclear power generation in steam plants, refrigeration, refining, heat transmission, etc

Video Links/Any other special information:

https://www.youtube.com/watch?v=j-TXp789inU

Module-4	RBT Level: L1, L2, L3	8 Hours

Radiation: Properties and definitions, Emissive power and intensity of radiation, Black body radiation, Grey body radiation, Stefan – Boltzmann law, Wein's displacement law, Kirchhoff's law, radiation shape factor, radiation between large parallel plates, Numerical Problems.

Experiential learning: Demonstrate how to determine the emissivity of a given grey body.

Applications: Emissivity is important in solar heat collectors, thermal shielding pyrometers and insulated windows.

Video Links/Any other special information:

https://www.youtube.com/watch?v=pbCf4507QvM		
Module-5	**RBT Level: L1, L2, L3**	**8 Hours**
Heat Transfer Equipment: Double pipe heat exchanger. Shell and tube heat exchangers, Condensers, Construction and working, Types of shell and tube heat exchangers, type of condensers. **Design of Heat Transfer Equipment:** Elementary design of double pipe heat exchanger. Shell and tube heat exchanger and condensers, Numerical Problems. **Evaporation:** Single and multiple effect operation, material and energy balance in evaporators, forward and backward feeds, capacity and economy of evaporators, Multiple effect evaporator – Methods of feeding. **Experiential learning: E**xhibit the working of heat exchangers, condensers, evaporators and boilers to get the complete understanding of the constructional details. **Applications**: They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. **Video Links/Any other special information:** https://www.youtube.com/watch?v=r67f4V6pOOw		

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

Text Books:	
1	McCabe, W. L., Smith, J. C., &Harriott, P. (1993). *Unit operations of chemical engineering* (Vol. 5, p. 154). New York: McGraw-hill.
2	Rao, Y. V. (2002).*Heat Transfer*. Universities Press.
Reference Books:	
1	Park, C. W. (1993). CHEMICAL ENGINEERING: Vol. 1. Fluid Flow, Hea t Transfer and Mass Transfer by JM Coulson and JF Richardson, with JR Backhurst and JH

	Harker. *Chemical Engineering Education*, *27*(3), 182-183.
2	Dutta, B. K. (2000). *Heat transfer: principles and applications*. PHI Learning Pvt. Ltd..
3	**Web Link and Video Lectures:** https://nptel.ac.in/courses/103103032/

Scheme of Evaluation		
Details		**Marks**
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e., ∑ (Marks Obtained in each test)/3	**CIE (50)**	**30**
Assignments (3 Nos.)		**10**
Self Assesment Test		**6**
Polling/Comprehensive questions		**4**
Semester End Examination	**SEE (50)**	**50**
	Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	0	0	0	0	0	0	0	0	0
CO2	2	3	3	2	0	0	0	0	0	0	0	0
CO3	2	3	3	2	0	0	0	0	0	0	0	0
CO4	2	3	3	0	0	0	0	0	0	0	0	0
CO5	2	3	3	0	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	**INSTRUMENTAL ANALYSIS**	**Semester**	IV
Course Code	MVJ20CH46	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 30 : 10 : 0	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	03	**Exam. Duration**	3 hrs

Course objective is to:

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

Module-1	**RBT Level: L1, L2, L3**	**8 Hours**

Chromatography: Introduction, classification of chromatographic methods based on the mechanism of separation. Column Chromatography: Adsorption and partition, theory, preparation, procedure and methods of detection. Thin Layer Chromatography: Theory, preparation, procedures, detection of compounds. Paper Chromatography: Theory, different techniques employed, filter papers used, qualitative and quantitative detection. Counter – current extraction, solid phase extraction techniques, gel filtration.

Module-2	**RBT Level: L1, L2, L3**	**8 Hours**

Gas chromatography: Introduction, fundamentals, instrumentation, columns: preparation and operation, detection, dramatization. **Liquid chromatography:** HPLC-Principles and instrumentation, solvents and columns, detection and applications.

Module-3	**RBT Level: L1, L2, L3**	**8 Hours**

Spectroscopy: Introduction, electromagnetic spectrum. **UV-Visible spectroscopy:** absorbance laws and limitations, instrumentation-design and working principle, chromophore and auxochromes concept, Wood-Fisher rules for calculating absorption maximum, applications of UV-Visible spectroscopy. **IR spectroscopy:** Basic principles-Molecular vibrations, vibrational frequency, factors influencing vibrational frequencies, sampling techniques, instrumentation, interpretation of spectra, FT-IR, theory and applications.

Module-4	**RBT Level: L1, L2, L3**	**8 Hours**

Mass spectroscopy: Theory, ionization techniques: electron impact ionization, chemical ionization, field ionization, fast atom bombardment, plasma desorption, fragmentation process: types of fission, resolution, GC/MS, interpretation of spectra and applications for identification and structure determination. **X-ray diffraction (XRD):** Bragg's law, basic powder diffraction, generation of X-rays, Instrumentation, Scherrer equation, BCC and FCC Bravais lattice, phase identification using XRD.

Module-5	RBT Level: L1, L2, L3	8 Hours

NMR: Theory, instrumentation, chemical shift, shielding and de-shielding effects, splitting of signals, spin-spin coupling, proton exchange reactions, coupling constant (J), Nuclear OverHauser effect (NOE), ^{1}H NMR, ^{13}C NMR spectra and its applications.

Laboratory Sessions:

Paper chromatography: Separation of colored substances in a mixture by using different solvents as mobile phase. **UV-Vis spectroscopy:** Quantitative determination of various analytes in a given sample by UV-visible spectroscopy.

Scheme of Evaluation

Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. Σ (Marks obtained in each test)/3	CIE(50)	30
Quizzes		4
Assignments		8
Experiments related to courses		8
Semester End Examination	SEE(50)	50
	Total	100

Course outcomes:

CO1	Discuss classification of chromatography and explain Thin Layer, Gas Chromatography and High Performance Liquid Chromatographic methods
CO2	Discuss types of spectroscopy, instrumentation and applications of UV Spectroscopy
CO3	Explain theory, instrumentation and applications of IR spectroscopy
CO4	Discuss principle, instrumentation and applications of Mass Spectroscopy and NMR spectroscopy
CO5	Discuss principle, instrumentation and applications of X-ray diffraction

Text Books:	
1.	Instrumental Methods of Chemical Analysis by B.K. Sharma
Reference Books:	
1.	Organic Spectroscopy by Y.R Sharma
2.	Text book of Quantitative Chemical Analysis by Vogel's A.I.
3.	Organic Spectroscopy by William Kemp

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	CHEMICAL ENGINEERING DRAWING LAB	Semester	IV
Course Code	MVJ20CHL47	CIE	50
Total No. of Contact Hours	20 L:T:P::0:10:10	SEE	50
No. of Contact Hours/week	3	Total	100
Credits	2	Exam. Duration	3 Hours

Course objective is to:

Draw the proportionate drawings of reaction vessel, jacked vessels, evaporator, STHE and also the assembly drawings of socket and spigot, flanged pipe and union joints etc with the help of solid edge software.

Sl No	Experiment Name	RBT Level	Hours
1.	**Sectional views:** Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.	L1, L2, L3	3
2.	**Proportionate drawings:** Equipment and piping symbols, Vessels components: Vessel openings, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel with the help of solid edge software and different types of Evaporators. P & I Diagrams.	L1, L2, L3	3
3.	**Assembly drawings:** Joints: Cotter joint with sleeve, Socket and Spigot joint, Flanged pipe joint, Union joint, Stuffing box and Expansion joint (Screw type or flanged type).	L1, L2, L3	3

Note:

- Assignments to be given to students to practice all the drawings and weightage shall given to these assignments while awarding IA marks.
- Minimum of Ten drawings are to be conducted.
- Examination consists of one question on proportionate drawing (30 marks) and question on Assembly drawing (70 marks).
- Examination to be conducted like other lab exams. Question paper should be prepa

jointly by Internal and External examiners. • Computer Aided drawing Software: Solid Edge or Equivalent Software.	
Course outcomes:	
CO1	Draw the general projections of given object.
CO2	Represent two-dimensional proportionate drawings of process symbols of various pipes and fittings.
CO3	Draw the proportionate drawings of reaction vessel, jacked vessels, evaporator, STHE and DPHE
CO4	Draw the assembly drawings of socket and spigot, flanged pipe and union joints showing sectional, front, top, and side views.
CO5	Demonstrate the usage of solid edge software tool for engineering drawing.

Scheme of Evaluation:

Details		**Marks**
Daily Evaluation	**CIE (50)**	**30**
Internal Assessment		**10**
Project Based Experiment		**10**
Semester End Examination	**SEE (50)**	**50**
	Total	**100**

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

High-3, Medium-2, Low-1

Course Title	MECHANICAL OPERATIONS LAB	Semester	IV
Course Code	MVJ20CHL48	CIE	50
Total No. of Contact Hours	40 L: T: P:: 0: 10: 30	SEE	50
No. of Contact Hours/week	3	Total	100
Credits	2	Exam. Duration	3 Hours

Course objective is to:

- Analyse the efficiency of various size reduction equipment's, Average particle size analysis, and to evaluate filtration and sedimentation processes

Sl No	Experiment Name	RBT Level	Hours
1.	Ball mill- verify the crushing laws using given sample	L1, L2, L3, L4	3
2.	Batch sedimentation- determine area of thickener required for given sample	L1, L2, L3, L4	3
3.	Free settling- determine settling velocity of various samples	L1, L2, L3, L4	3
4.	Drop weight crusher- verify the crushing laws using given sample	L1, L2, L3, L4	3
5.	Sieve analysis-find the particle size distribution of the given sample	L1, L2, L3, L4	3
6.	Screen effectiveness-find the separation efficiency of given screen.	L1, L2, L3, L4	3
7.	Jaw crusher- verify the crushing laws using given sample	L1, L2, L3, L4	3
8.	Leaf filter-find the specific cake resistance	L1, L2, L3, L4	3
9.	Air elutriation - find the particle size distribution of the given sample	L1, L2, L3, L4	3
10.	Air permeability- find the specific surface area of the particles of a given sample	L1, L2, L3, L4	3
11.	Grindability index	L1, L2, L3, L4	3
12.	Froth floatation- Efficiency of frothing agent in separating given ore sample	L1, L2, L3, L4	3
13.	Plate and frame filter press - find the specific cake resistance	L1, L2, L3, L4	3

14.	Cyclone separator- Efficiency of separation	L1, L2, L3, L4	3

Course outcomes:	
CO1	Explain properties of particulate solids, handling and mixing of solid particles.
CO2	Analyse principles and different types of size reduction equipment's like crushers, grinders etc.
CO3	Evaluate the effectiveness of screening, filtration, sedimentation, of solids etc.
CO4	Evaluate energy requirements in solids handling, agitation and mixing, solid conveying and storage.
CO5	Conduct experiments on some of the basic unit operations such as separation size reduction.

Text Books:	
1.	McCabe, W. L., Smith, J. C., &Harriott, P. (1993). *Unit operations of chemical engineering* (Vol. 5, p. 154). New York: McGraw-hill.
2.	Badger, W. L., &Banchero, J. L. (2010). Introduction to chemical engineering. 25th reprint.

Reference Books:	
1.	McCoy, B. J. (1993). CHEMICAL ENGINEERING: Vol. 2. Particle Technology and Separation Processes, by JM Coulson, JF Richardson, JR Backhurst, and JH Harker. *Chemical Engineering Education*, *27*(3), 183-199.
2.	Montillon, G. H. (1951). Unit Operations. By GG Brown, AS Foust, DL Katz, R. Schneidewind, RR White, WP Wood, JT Banchero, GM Brown, LE Brownell, JJ Martin, GB Williams, and JL York. *The Journal of Physical Chemistry*, *55*(4), 614-616.
3.	Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., & Andersen, L. B. (2008). *Principles of unit operations*. John Wiley & Sons.
4.	Web Link and Video Lectures: 1. https://nptel.ac.in/courses/103107123/ 2. https://swayam.gov.in/nd1_noc19_ch32/preview

Scheme of Evaluation		
Details		**Marks**
Regular Lab Work	**CIE (50)**	**20**
Record Writing		**5**
Lab Test (minimum 2 tests shall be conducted for 15 marks and average of two will be taken)		**15**

Viva		10
Write up	SEE (50)	10
Conduction		20
Analysis of results		10
Viva		10
Total		100

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	0	0	0	0	0	0	0	0	0
CO2	2	2	2	2	0	0	0	0	0	0	0	0
CO3	2	2	2	2	0	0	0	0	0	0	0	0
CO4	2	2	2	0	0	0	0	0	0	0	0	0
CO5	2	2	2	2	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW	Semester	IV
Course Code	MVJ20CPH49	CIE	50
Total No. of Contact Hours	15 L : T : P :: 15 :0 : 0	SEE	50
No. of Contact Hours/Week	01	Total	100
Credits	01	Exam. Duration	2 hrs

Course objective is to:

- To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.
- To provide overall legal literacy to the young technocrats to manage complex societal issues in the present scenario.
- To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.

Module-1	RBT Level: L1, L2, L3	3 Hours

Introduction to Indian Constitution

The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.

Module – II	RBT Level: L1, L2, L3	3 Hours

Union Executive and State Executive

Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.

Module – III	RBT Level: L1, L2, L3	3 Hours

Elections, Amendments and Emergency Provisions

Elections, Electoral Process, and Election Commission of India, Election Laws.

Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements).

Emergency Provisions, types of Emergencies and it's consequences.

Constitutional Special Provisions: Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.

Module – IV	**RBT Level: L1, L2, L3**	**3 Hours**

Professional / Engineering Ethics: Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.

Module – V	**RBT Level: L1, L2, L3**	**3 Hours**

Internet Laws, Cyber Crimes and Cyber Laws:

Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.

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

Text Books:	
1.	Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher
Reference Books:	

1.	Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th/20thEdn., (Latest Edition) or 2008.
2.	Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.
3	M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice – Hall of India Pvt. Ltd. New Delhi, 2004.
4.	M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
5.	Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests - Assignment (10 marks)
SEE Assessment:
i. Question paper for the SEE consists one part. It is compulsory and consists of objective type 1 mark each for total of 50 marks covering the whole syllabus. ii. Ten questions must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**ADDITIONAL MATHEMATICS-II** **(COMMON TO ALL BRANCHES)**	**Semester**	IV
Course Code	MVJ20MATDIP41	**CIE**	50
Total No. of Contact Hours	40	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	-	**Exam. Duration**	3hrs

Course objective is to: This course viz., aims to prepare the students:

To familiarize the important tools Linear Algebra, differential Calculus, Beta and Gamma functions, 3-Dimentional Geometry and probability for analysing the engineering problems.

Module-1	**RBT Level: L1, L2**	**8 Hours**

Linear Algebra: Introduction, Rank of a matrix-echelon form. Solution of system of linear equations – consistency. Gauss-elimination method and problems. Eigen values and Eigen vectors of square matrix of order two and Problems.

Video Link:

https://www.math.ust.hk/~machas/matrix-algebra-for-engineers.pdfhttps://nptel.ac.in/content/storage2/courses/122104018/node18.html

Module-2	**RBT Level: L1, L2**	**8 Hours**

Differential calculus: Tangent and normal, both Cartesian and polar forms. Increasing and decreasing functions, Maxima and Minima for a function of one variable. Point of inflections and Problems. **Beta and Gamma functions:** Beta and Gamma functions, Relation between Beta and Gamma function-simple problems.

Video Link:

https://www.youtube.com/watch?v=6RwOoPN2zqE

https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11

http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx

Module-3	**RBT Level: L1, L2**	**8 Hours**

Analytical solid geometry: Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems.

Video Link: https://www.toppr.com/guides/maths/three-dimensional-geometry/ https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/		
Module-4	**RBT Level: L1, L2, L3**	**8 Hours**
Probability: Random variable, Discrete probability distribution, Mean and variance of Random Variable, Theoretical distribution- Binomial distribution, Mean and variance Binomial distribution -Problems. Poisson distribution as a limiting case of Binomial distribution, Mean and variance of Poisson distribution. Normal Distribution-Basic properties of Normal distribution –standard form of normal distribution and Problems. Video Link: https://nptel.ac.in/courses/111/105/111105041/ https://www.mathsisfun.com/data/probability.html		
Module-5	**RBT Level: L1, L2**	**8 Hours**
Partial differential equation: Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only. Video Link: http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method-of- variation-of-parameters		
Course outcomes:		
CO1	Apply the knowledge of Matrices to solve the system of linear equations and to understand the concepts of Eigen value and Eigen vectors for engineering problems.	
CO2	Demonstrate various physical models ,find Maxima and Minima for a function of one variable., Point of inflections and Problems .Understand Beta and Gamma function	
CO3	Understand the 3-Dimensional geometry basic, Equation of line in space-different forms, Angle between two line and studying the shortest distance.	
CO4	Concepts of Probability related to engineering applications.	
CO5	Construct a variety of partial differential equations and solution by exact methods.	

Text Books:	
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, 10thedition,2014.
2	G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (10 marks)
- Assignment (10 marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	2	0	0	0	0	0	0	1	1
CO2	3	3	0	2	0	0	0	0	0	0	1	1
CO3	3	3	0	3	0	0	0	0	0	0	0	1
CO4	2	2	0	3	0	0	0	0	0	0	1	1
CO5	2	2	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1