Semester: IV		
Complex Variables and Numerical Methods (Theory)		
Course Code	MVJ21MME41	CIE Marks: 50
Credits	L:T:P:: 2:2:0	SEE Marks: 50
Hours	20L+20T	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Understand the concepts of Complex variables and transformation for solving Engineering Problems.	
2	Understand the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems.	
3	Apply the concept to find extremal of functionals.	
4	Solve initial value problems using appropriate numerical methods.	
5	Students learn to obtain solutions of ordinary and partial differential equations numerically.	

UNIT-I	
Complex variables - I: Functions of complex variables, Analytic function, Cauchy-Riemann Equations in Cartesian and polar coordinates, Consequences of Cauchy-Riemann Equations, Construction of analytic functions (Using Milne-Thomson method). **Transformations:** Bilinear Transformation, Conformal transformation, Discussion of the transformations $w = z^2$, $w = e^z$ and $w = z + \frac{a}{z}, (z \neq 0)$. **Self Study topic** : Harmonic function and its properties **Web Link and Video Lectures:** https://nptel.ac.in/courses/111103070	8 Hrs
UNIT-II	
Complex variables-II: Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series- Problems, Singularities, Types of Singularities, Poles, Residues-definitions, Cauchy residue theorem - Problems. **Self Study topic:** Consequences of Cauchy's theorem, Cauchy residue theorem. **Web Link and Video Lectures:** https://nptel.ac.in/courses/111103070	8 Hrs
UNIT-III	
Numerical methods-I: Numerical solution of Ordinary Differential Equations of first order and first degree, Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order, Milne's and Adam-Bashforth Predictor and Corrector method. **Web Link and Video Lectures:** https://nptel.ac.in/courses/127106019	8 Hrs
UNIT-IV	

Numerical methods-II: Numerical solution of Ordinary Differential Equations of second order: Runge-Kutta method of fourth order, Milne's Predictor and Corrector method. **Calculus of variations**: Variation of function and Functional, variational problems, Euler's equation, Geodesics. **Applications** : Hanging Chain problem. **Self Study topic** : Adam-Bashforth Predictor and Corrector method. **Web Link and Video Lectures:** https://nptel.ac.in/courses/127106019 https://nptel.ac.in/courses/111107103	8 Hrs
UNIT-V	
Numerical methods-III: Numerical solution of Partial Differential Equations: Introduction, Finite difference approximations to derivatives, Explicit methods-Numerical Solution of Laplace Equation, Numerical solution of one-dimensional heat equation by Bender - Schmidt's method and by Crank-Nicholson Method, Implicit method-Numerical solution of one-dimensional wave equation. **Self Study topic**: Classification of Partial differential equations, Parabolic, Elliptic and Hyperbolic equations. **Web Link and Video Lectures:** https://nptel.ac.in/courses/111107063	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
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	Identify appropriate numerical methods to solve ODE.
CO4	Determine the extremals of functionals and solve the simple problems of the calculus of variations.
CO5	Choose appropriate numerical methods to solve Partial Differential Equations.

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

High-3, Medium-2, Low-1

Semester: IV		
THEORY OF MACHINES (Theory)		
Course Code: MVJ21ME42		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40 L		SEE Duration: 03
Course Learning Objectives: The students will be able to		
1	Explain the types of relative motion to differentiate between Machine, Mechanism, and Structure	
2	Draw velocity and acceleration diagrams of linkages.	
3	Determine gear parameters and determine train value & fixing torque in gear trains.	
4	Design Cam profile for the desired follower motion.	

UNIT-I	
Introduction: Definition of link, pair, kinematic chain, mechanism, machine, inversion, structure – Types of motion, Grashof's criterion, Inversions of 4 bar chain, single slider crank chain and double slider crank chain – Degrees of freedom – Gruebler's criterion for mobility of mechanisms. **Mechanisms**: Drag link and toggle mechanisms – Straight line mechanisms, Condition for exact straight line motion, Peaucellier and Hart mechanisms – Intermittent motion mechanisms, Ratchet and pawl and Geneva wheel – Pantograph, Condition for perfect steering, Steering gear mechanisms, Ackermann– Hooke's joint, Oldham's Coupling.	8 Hrs
UNIT-II	
Velocity and Acceleration: Determination of velocity and acceleration of a point/link in simple mechanisms by relative velocity method (graphical) – Coriolis component of acceleration. **Instantaneous centre** – Centrodes – Kennedy's theorem – To determine linear velocity and angular velocity of links of simple mechanisms by instantaneous centre method. Klein's Construction for velocity and acceleration of slider crank mechanism.	8 Hrs
UNIT-III	
Spur Gear: Classification of toothed wheels – Gear terminology –Law of gearing –Velocity of sliding – Length of path of contact, Arc of contact – Contact ratio – Interference in involute gears, Methods of avoiding interference –Minimum number of teeth to avoid interference on pinion meshing with gear and on pinion meshing with rack. Characteristics of involutes action, Comparison of involute and cycloidal teeth profiles. Numerical problems.	8 Hrs
UNIT-IV	
Gear Trains–Velocity ratio & Train value, Types of gear trains– Simple, Compound, Reverted & Epicyclic gear trains. Algebraic/Tabular method of finding Train value of Epicyclic gear trains. Numerical problems.	8 Hrs
UNIT-V	
Cams: Types of cams, Types of followers and types of follower motion – Displacement, velocity and acceleration curves for SHM, Uniform velocity, UARM and Cycloidal motion – To draw cam profile for disc cam with reciprocating	8 Hrs

follower (knife edge, roller and flat faced)– To find maximum velocity and acceleration in each case.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Define the basic mechanisms for developing a machine.
CO2	Construct velocity and acceleration diagram for mechanism.
CO3	Design and synthesize mechanisms for specific type of relative motion.
CO4	Estimate kinematic parameters for industrial mechanism of gears.
CO5	Construct the Cams for various followers.

Reference Books	
1.	S S RATHAN: "Text Book of Theory of Machines", 4th Edition, McGraw-Hill Education,(INDIA) private limited , ISBN 007-059120-2
2.	SADHU SINGH : "Theory of Machines", 2nd Edition, Pearson Education Publications, 2007, ISBN-13 : 978-8177581270
3.	R S KHURMI, J K GUPTA: "A Text Book of Theory of Machines", S CHAND publication. ISBN-13:978-8121910019
4.	GHOSH A. AND MALLICK A.K : "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd, New Delhi, 1988. ISBN-13:978-8185938936

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/112105268/
2. https://swayam.gov.in/nd1-noc20-me21/
3. https://nptel.ac.in/courses/1121/104/112104121/
4. https://nptel.ac.in/courses/1121/104/112104121/
5. https: //nptel.ac.in/courses/1121/104/112104121/

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

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

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

Semester: IV		
Advanced Manufacturing Technology (Theory)		
Course Code: MVJ21ME43		CIE Marks: 50
Credits: L:T:P: 3:0:0		SEE Marks: 50
Hours: 40 L		SEE Duration: 03

Course Learning Objectives: The students will be able to	
1	Recognize the mechanics of machining processes and cutting tool materials.
2	Recognize the different machine tool types and parts and operational features.
3	Write part programs using G codes and M codes for different part profiles.
4	Recognize the different high energy rate forming and additive manufacturing techniques.
5	Elucidate advanced machining processes and micro machining and nano machining techniques.

UNIT-I	
Mechanics of Machining Processes: Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built- Up-Edge and its effect in metal cutting, Merchant's analysis of metal cutting process - Various forces, power and specific energy in cutting, Numericals. **Cutting Tool Materials**: Geometry and Surface Finish, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, Tool Life and Machinability, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.	8 Hrs
UNIT-II	
Lathe and Milling Machine: Lathe, Types, Construction, Operations, Advantages and Limitations. Milling Machine, Types, Construction, Operations, Advantages and Limitations. Cutting Speed, Feed, Depth of cut, Machining Time and Cost Calculations. **Drilling and Reciprocating Machine**: Drilling Machine, Types, Construction, Operations, Advantages and Limitations. Shaper – Types, Construction, Operations, Advantages and Limitations. Cutting Speed, Feed, Depth of cut, Machining Time and Cost Calculations.	8 Hrs
UNIT-III	
CNC Tooling and Programming: CNC Tooling, Tool and work holding devices, Automatic Tool Changers, Automatic Pallet Changers. CNC Programming: Introduction-G Codes and M Codes, Part Program and its elements, Methods of Programming: Manual and Computer Assisted Part programming, APT language.	8 Hrs
UNIT-IV	
High Energy Rate Forming Methods: Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic forming. **Introduction to Additive Manufacturing**: Definition, Classification of Additive Manufacturing Processes-Process parameters, Advantages, Limitations and Applications.	8 Hrs
UNIT-V	

Advanced Machining Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, Electro-chemical machining (ECM), Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining. **Micro Machining and Nano Machining**: Micro Machining and Nano Machining, Types, Process parameters, Advantages, Limitations, and Applications.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the principle of machining and mechanics of metal cutting
CO2	Identify and explain the principle behind operations of lathe and milling machines.
CO3	Understand G codes, M codes and write simple programs for turning and milling operations.
CO4	Understand the process of High Energy Rate forming methods.
CO5	Categorize and explain the non-conventional Machining Process and its applications.

Reference Books	
1.	M. C. Shaw, Theory of Metal Cutting, Oxford and I.B.H. Publishing, 1st edition, 1994.
2.	Milkell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, John Wiley and Sons, New Jersey, 4th edition, 2010.
3.	P.C. Pandey and H. S. Shan, "Modern Machining Process", Tata McGraw-Hill Publishing company Ltd. 33rd Reprint.
4.	Hajra Choudhury S K, Elements of Workshop Technology Vol 2 Machine Tools Paperback – 1 January 2010. Indian Book Distributing Co. Calcutta. ISBN-13 : 978-8185099156.

Web links and Video Lectures (e-Resources):

1. Introduction to Non-Traditional Machining by N. Sinha Department of Mechanical Engineering IIT Kanpur : Video Lecture -- https://nptel.ac.in/courses/112105212/
2. Metal Cutting and Machine Tools by Prof. Asimava Roy Choudhury, Department of Mechanical Engineering, IIT Kharagpur : Video Lecture -- https://archive.nptel.ac.in/courses/112/105/112105233/

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

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

Semester: IV		
Metrology and Measurements Theory and Practice		
Course Code: MVJ21ME44		CIE Marks:50+50
Credits: L:T:P: 3:0:2		SEE Marks: 50 +50
Hours:40 L+ 26 P		SEE Duration: 03+03 Hours

Course Learning Objectives: The students will be able to	
1	To provide a basic knowledge about measurement systems and their components
2	To learn about various sensors used for measurement of mechanical quantities.
3	To learn about system stability and control and integrate the measurement systems with the process for process monitoring and Control.
4	To develop competence in sensors, transducers and terminating devises with associated parameters and illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
5	Illustrate the use of various measuring tools & measuring techniques along with understanding the calibration techniques of various measuring devices

UNIT-I	
Prerequisites: Basics of measurements and measuring systems. **Basic Concepts of Measurement and Metrology**: Definition and significance of measurement, Generalized measurement system, Performance characteristics of measuring instruments (Only static characteristics), Inaccuracy of Measurements, Definition and objectives of metrology. Standards, Subdivision of standards, Line and end standard, Imperial standard yard, Wave length standard, International Prototype meter, Transfer from line to end standard. Calibration of end bars, Slip gauges, Wringing phenomena, Numerical problems on building of slip gauges. **Laboratory Sessions/ Experimental learning**: • Building dimensions using slip gauges and angle gauges. **Applications**: Measurement and manufacturing of other processes, defect detection, Calibration and quality Control. **Video link / Additional online information** : https://lake.videoken.com/nptel/search/Metrology%20/video/BqAmlOl8uzs?tocitem=4	8 Hrs
UNIT-II	
Prerequisites: Basics of limits, types of fits, holes and shafts. **System of Limits, Fits, Tolerances and Gauging**: Definition of tolerance, specification in assembly, Principle of inter-changeability and selective assembly. Concept of limits of size and tolerances, Compound tolerances, accumulation of tolerances. Definition of fits, types of fits. Hole basis system and shaft basis system, Geometric dimensioning and tolerance. Classification of gauges, Basic concept of design of gauges (Taylor's principles), wear allowance on gauges. Types of gauges -plain plug gauge, ring gauge, snap gauge, gauge materials. Gauge Design and numerical problems. **Laboratory Sessions/ Experimental learning**:	8 Hrs

• Study and use of; plug gauge and ring gauges, calculation of wear allowance. **Applications**: Providing Allowances and clearance for various applications of holes and shafts. **Video link / Additional online information**: https://lake.videoken.com/nptel/search/System%20of%20Limits%20and%20Fits	
UNIT-III	
Prerequisites: Basics of comparators, pressure gauges, screw thread, and gears. **Comparators**: Characteristics and classification of comparators. Mechanical comparators-Johnson Mikrokator, Sigma Comparators, Optical Comparators - principles, Zeiss ultra-optimeter, Electric and Electronic Comparators, LVDT, Pneumatic Comparators, Solex Comparator, Back Pressure gauges. **Metrology of Screw Thread and Gear**: Measurement of basic elements of thread, Screw threads: 2- wire and 3-wire methods. Gear tooth terminology, Base-tangent method, Constant chord method, Measurement of pitch, Gear roll tester. Basic concepts of Coordinate measuring machines-construction and applications. **Laboratory Sessions/ Experimental learning**: • Study and Operation of different comparators and pressure gauge. • Experimental Verification of base tangent method and constant chord method. • Study of Coordinate measuring machines, its applications. • Measurement of screw thread and Gear parameters. **Applications**: Compare voltages and currents to measure minute and micro displacements. **Video link / Additional online information** : https://lake.videoken.com/nptel/search/Comparators%20	8 Hrs
UNIT-IV	
Prerequisites: Basic of sensors, transducers, amplifiers and CRO. **Transducers**: Introduction, Transfer efficiency, Loading effect, Primary and Secondary transducers, classification of transducers with examples. Advantages of each type transducers. Signal Conditioning: Mechanical systems, Electrical intermediate modifying devices, Input circuitry simple current sensitive circuit, Electronic amplifiers, Filters, Types of filters, telemetry, Cathode ray oscilloscope, Oscillographs. **Laboratory Sessions/ Experimental learning**: • Application of oscillograph and CRO. **Applications**: Automation and control of Electronic circuits, wireless communication and broadcasting. **Video link / Additional online information** : https://lake.videoken.com/nptel/search/Transducers/	8 Hrs
UNIT-V	
Prerequisites: Basic of strain, force, torque and temperature. **Strain Measurement**: Methods of strain measurement, Strain gauges, Preparation and mounting of strain gauges, Gauge factor. **Measurement of Force**: Introduction, Proving ring. **Measurement of Torque**: Introduction, Prony or Brake Dynamometer, Hydraulic dynamometer.	8 Hrs

Measurement of Pressure: Introduction, Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani Gauge. **Temperature Measurement**: Resistance thermometers, Wheatstone bridge circuit, Thermocouple, Laws of thermocouple, Thermocouple materials. Pyrometers, Optical pyrometers. **Laboratory Sessions/ Experimental learning**: • Study of strain gauge and application. Study of thermistors, resistance thermometers and its operation. Study of pyrometer, thermocouple and its use. **Applications**: measurement of strain in load bearing structures along load paths, temperature/pressure gradient in high pressure vessels. **Video link / Additional online information**: https://lake.videoken.com/nptel/search/Strain%20gauge/	

LABORATORY EXPERIMENTS

1. Calibration of Pressure Gauge,
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
6. Measurements using Optical Projector / Toolmakers' Microscope.
7. Measurement of angle using Sine Centre / Sine bar / bevel protractor
8. Measurement of alignment using Autocollimator / Roller set
9. Measurements of surface roughness using Tally Surf/Mechanical Comparator
10. Measurement of gear tooth profile using gear tooth Vernier/Gear tooth micrometer
11. Calibration of Micrometer using slip gauges
12. Measurement using Optical Flats

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the objectives of metrology, methods of measurements, selection of measuring instruments, standards of measurement and calibration of end bars.
CO2	Describe the slip gauges, wringing of slip gauges and building of slip gauges, angle measurement using sine bar, sine center, angle gauges, optical instruments and straightness measurement using Autocollimator.
CO3	Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.
CO4	Understand the principle of comparators, dial indicator, LVDT, pressure gauges, comparator and measuring devices.
CO5	Understand Calibration of pressure gauge, thermocouple, LVDT, load cell, micrometer. Apply concepts of Measurement of angle using Sine Centre/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set. Demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats. Analyse tool forces using Lathe/Drill tool dynamometer. Analyse Screw thread parameters

	using 2-Wire or 3-Wire method, gear tooth profile using gear tooth Vernier/Gear tooth micrometer.

Reference Books : Title, Author, Edition, year of publication, publisher, ISBN	
1.	E.O. Doebelin, **"Measurement Systems (Applications and Design)"**, 5th ed.- - McGrawHill. 2004, 9780072438864, 007243886X.
2.	**Beckwith Marangoni and Lienhard, "Mechanical Measurements"** Pearson Education, 6th Ed., 2006. ISBN-13 - **978-0201847659**
3.	**Richard S Figliola, Donald E Beasley "Theory and Design for Mechanical Measurements",** 3rd edition, WILEY India Publishers. ISBN-13 978-0471000891
4.	**R.K. Jain, "Engineering Metrology",** Khanna Publishers, Delhi, 2009. ISBN-13 978-8174091536

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

Semester: IV		
Machine Drawing and Operations (Theory and Practice)		
Course Code: MVJ21ME45		CIE Marks:100
Credits: L:T:P: 3:0:2		SEE Marks: 100
Hours: 40L+26P		SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To acquire the knowledge of CAD software and its features. Make the students to understand of the devices, instruments.	
2	To expose the students to CNC Machine Tools, CNC part programming	
3	To provide an insight to different machine tools, accessories and attachments.	

UNIT-I	
Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. **Orthographic views**: Conversion of pictorial views into orthographic projections of simple machine parts with and without section. (Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines. **Laboratory Sessions/ Experimental learning**: Conversion ISO view to orthogonal view of different machine components to be done using available software tool in the lab. **Applications**: All manufacturing Industry. **Video link / Additional online information**: 1. https://www.youtube.com/watch?v=-_qz8_sbhwY 2. https://www.youtube.com/watch?v=zO8coRhrJM0	8 Hrs
UNIT-II	
Thread forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal and External), square, Acme and Sellers thread, American Standard thread. *Fasteners:* Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. **Laboratory Sessions/ Experimental learning**: 2D drawing of a different type of threads are practiced using available software tool in the lab and same threads are manufactured in M/C shop. **Applications**: Assembly and sub assembly of components. **Video link / Additional online information**: 1. https://www.youtube.com/watch?v=TPURJnlekeo	8 Hrs

2. https://www.youtube.com/watch?v=Z38Aq9ykUCM	
UNIT-III	
Riveted joints: Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters). Laboratory Sessions/ Experimental learning: Lap and Butt joint of different plate thickness are drawn using soft wear. Applications: Bridge construction, Boiler construction, Automobile sheet metal assembly. Video link / Additional online information: 1. https://www.youtube.com/watch?v=C5ZPaCvoigw	8 Hrs
UNIT-IV	
Joints: Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods. Laboratory Sessions/ Experimental learning: 2D Drawing are drawn using software & 3D individual parts are made and assembled as per given drawing. Applications: Power transmission assembly, Automobile (Heavy Trucks) industry. Video link / Additional online information: 1. https://www.youtube.com/watch?v=J9Aj17MAyLY 2. https://www.youtube.com/watch?v=esfr74WhbYg 3. https://www.youtube.com/watch?v=qjGF08LvZ9M	8 Hrs
UNIT-V	
Assembly Drawings: (Part drawings shall be given) 1. Plummer block (Pedestal Bearing) 2. I.C. Engine connecting rod 3. Screw jack (Bottle type) 4. Tailstock of lathe 5. Machine vice 6. Lathe square tool post Laboratory Sessions/ Experimental learning: 3D individual parts are made and assembled as per given drawing. Applications: Heavy equipment manufacturing, IC engine manufacturing, Automotive industry. Video link / Additional online information: 1. https://www.youtube.com/watch?v=boyN1l3fA6g&list=PLQL-DlNb9_TVqG1Zrw-9F-S0LItg3T5fD	8 Hrs

2. https://www.youtube.com/watch?v=yKl_FiUdAu4&list=PLQL-DlNb9_TUHs8CUXYw-Lna-Gp4rTu9g 3. https://www.youtube.com/watch?v=pyzsBiU-raE&list=PLQL-DlNb9_TXofoObUwlRjLzPst-sRbG3	

Laboratory Experiments

1. Preparation of three models on lathe involving - Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
2. Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
3. Cutting of Gear Teeth using Milling Machine.
4. Preparation of at least two fitting joint models by proficient handling and application of hand tools- V block, marking gauge, files, hack saw, drills etc.
5. CNC Part programming for turning operations using CAM simulation software
6. CNC Part programming for milling operations using CAM simulation software
7. Demonstration on CNC milling and turning operations.
8. Demonstration of Robot programming for pick and place and stacking operations.

Course Outcomes: After completing the course, the students will be able to	
CO1	Upon completion of this course, the students can able to apply mathematical knowledge to Calculate the deformation behaviour of simple structures.
CO2	Critically analyse problem and solve the problems related to mechanical elements and analyse the deformation behaviour for different types of loads.
CO3	Analyse the deflection in beams.
CO4	Analyse buckling and bending phenomenon in columns, struts and beams.
CO5	Analysis of shaft for various cross sections.

Reference Books	
1.	Serope Kalpakjian, Steuen. R, Sechmid, "Manufacturing Technology" Pearson Education Asia, 5th Ed. 2006.
2.	S. Trymbakaa Murthy, "A Text Book of Computer Aided Machine Drawing" CBS Publishers, New Delhi, 2007.
3.	Mikell P Groover, "*Automation, Production Systems and Computer-Integrated Manufacturing*", 4th Edition, 2015, Pearson Learning.
4.	**Computer Aided Machine Drawing** by K R Gopala Krishna, ASIN : B079Z9BG2L Publisher : Subhas Stores (1 January 2015)

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

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

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

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

Semester: IV		
CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (Theory)		
Course Code: MVJ21CPH46		CIE Marks:50
Credits: L:T:P: 1:0:0		SEE Marks: 50
Hours:15L		SEE Duration: 02 Hours
Course Learning Objectives: The students will be able to		
1	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.	
2	To provide overall legal literacy to the young technograts to manage complex societal issues in the present scenario.	
3	To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.	

UNIT-I	
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.	3Hrs
UNIT-II	
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.	3Hrs
UNIT-III	
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.	3Hrs

Constitutional Special Provisions: Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.	
UNIT-IV	
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.	3Hrs
UNIT-V	
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.	3Hrs

Course Outcomes: After completing the course, the 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.
Reference Books	
1.	Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher
2.	Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th/20th Edn., (Latest Edition) or 2008.
3.	Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE for 50 marks, executed by way of tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 40 marks and assignment is evaluated for 10 marks. The three tests are conducted for 40 marks each and the average of all the tests are calculated for 40. The marks for the assignments are 10 (2 assignments for 5 marks each). The marks obtained in test and assignment are added and report CIE for 50 marks.

Semester End Examination (SEE):

SEE for 50 marks, executed by means of an examination. The Question paper contains objective type questions for 50 marks covering the entire syllabus having same complexity in terms of COs and Bloom's taxonomy level.

Total marks: 50+50=100

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

Semester: IV		
Geometric Dimensioning and Tolerancing (AEC)		
Course Code: MVJ21MEA47		CIE Marks: 50
Credits: L:T:P: 1:0:2		SEE Marks: 50
Hours: 15L+20P		SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Define the geometry of model.	
2	Specify Dimensions on the model	
3	Specify All types of tolerances on the model	

UNIT-I	
Basic Concepts: General terms and definitions of geometrical features - General principle of sizes - System of limits and fits - Principles of dimensioning - Introduction to geometric dimensioning and tolerancing (GD&T) - Inspection of dimensional and geometrical deviations - Datums and datum systems Laboratory Sessions/ Experimental learning: Drawing Gear Components with basic GD&T Video link / Additional online information: https://www.youtube.com/watch?v=LClcXsvzUoY	7 Hrs
UNIT-II	
Form and Orientation Tolerances: Form tolerances: types, specifications and interpretations - measurement and evaluation of straightness, flatness and roundness - Orientation tolerances: types, specifications and interpretations, and verification of orientation tolerances. Laboratory Sessions/ Experimental learning: Providing Form and Orientation tolerances in Drawing sheet for a machine component. Video link / Additional online information: https://www.youtube.com/watch?v=-9Ixr0bw2Rk	7 Hrs
UNIT-III	
Location, Runout and Profile Tolerances: Tolerances of location: types, specifications and interpretations - verification techniques - Tolerances of profiles of lines and surfaces with or without datums - Tolerances of runout - Tolerancing of angles and cones. Laboratory Sessions/ Experimental learning: Providing Location, Runout and profile tolerances in Drawing sheet for a machine component. Video link / Additional online information: https://www.youtube.com/watch?v=jxwhF7hl0vo	7 Hrs
UNIT-IV	
Surface Roughness–Various parameters and their measurements in two dimensions - filtering and filtering techniques - areal parameters.	7 Hrs

Laboratory Sessions/ Experimental learning: Profilometer Experiment **Video link / Additional online information :** https://www.youtube.com/watch?v=dzhh82H2Nuk	
UNIT-V	
Related Topics: Vectorial dimensioning and tolerancing - Statistical tolerancing of mechanical assemblies - Dimensional chains - Measurement uncertainty - Computer-aided tolerancing and verification. **Video link / Additional online information:** https://www.youtube.com/watch?v=PcDaJBzSK90	7 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Systematically introduce the essentials of the language of geometric dimensioning and tolerancing (GD&T) based on ASME and ISO standards, as well as the essentials of surface roughness measurements in both 2D and 3D including filtering techniques
CO2	Systematically introduce the related concepts of Vectorial dimensioning and tolerancing, dimensional chains, measurement uncertainty, etc.
CO3	Get knowledge about the surface roughness
CO4	Gain knowledge about the statistical tolerance
CO5	The knowledge gained by the students by learning the above topics will help them to perform very well in their profession as metrologists as well as product designers.

Reference Books	
1.	GEOMETRIC DIMENSIONING & TOLERANCE (GD&T) REFERENCE GUIDE BOOK, edition, 1 January 2016
2.	Meadows, J. D., Geometric Dimensioning and Tolerancing: Applications and Techniques for use in Design, Manufacturing and Inspection, Marcel Dekker, Inc., New York. Edition, 4 May 1995
3.	Drake, P. J., Dimensioning and Tolerance Handbook, McGraw-Hill, 1st edition (16 November 1999)
4.	Gill, P. S., Geometric Dimensioning and Tolerancing, S. K. Kataria & Sons, New Delhi. Edition: 2nd Edition, 2013

Continuous Internal Evaluation (CIE):
Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

Semester: IV		
SUMMER INTERNSHIP-I (Theory and Practice)		
Course Code: MVJ21INT48		CIE Marks: -
Credits: 02		SEE Marks: -
Hours: -		SEE Duration: -

Course Learning Objectives: The students will be able to	
1	Get an inside view of an industry and organization/company
2	Gain valuable skills and knowledge
3	Make professional connections and enhance student's network
4	Get experience in a field to allow the student to make a career transit
5	To build a record of work experience and construct a good relationship with the employers.

Guidelines

- Students have to undergo this training for a period of 4 weeks (minimum) during the vacation between even and odd semesters.
- The internship will be considered as a head of passing and will be considered for the award of the degree. Those who do not take up / complete the internship will be declared fail and will have to complete during the subsequent examination after satisfying the internship requirements.
- The department shall nominate a faculty as a mentor for a group of students to prepare and monitor the progress of the students
- The students shall report the progress of the internship to the mentor/guide at regular intervals and may seek his/her advice.
- After completion of Internship, students shall submit a report to the department with the approval of both internal and external guides/mentors.
- Evaluation of Internship shall be conducted during VIII semester by internal and external examiners for 100 marks.
- The external examiner shall be from the industry where the student carried out the internship. In case of non-availability of external examiner, the concerned head of the department shall appoint an external examiner from the nearby college or a senior faculty member from outside the department in consultation with respective BOE and approved by Principal
- The internship carries three credits. A student has to get a minimum of 40% marks for a pass. If the student fails to complete the same then internship has to be repeated in its entirely
- The breakup of marks for the evaluation of training is as in table.

Evaluation by the supervisor under whom the training was carried out	25 Marks
Evaluation by DSEC	
1. Relevance of the Field training/Industrial Internship	10 Marks
2. Report	25 Marks
3. Evaluation	40 Marks
Total	100

Course outcomes:	
CO1	To experience a 4 weeks' internship training, enabling the student for onsite visits, study projects and practical training.
CO2	To develop a skill for handling multiple situations, practical problems, analyzing teamwork and communication abilities
CO3	To integrate theory with practice and carry out performance objectives on strong work ethics, persistence, adaptability and critical
CO4	To analyze work environment and create solution to problems.
CO5	To build a record of work experience and construct a good relationship facilitating him to become a team player in his career.

Reference Books:	
1	T1.Pamela Myers Kiser, "Human Services Internship: Getting the Most From Your Experience", Cengage Learning, 4th Edition, 2016. (ISBN13: 978-1305087347)
2	T3.H. Frederick Sweitzer, "Successful Internship", Brooks/Cole Publishing Co., 5th Edition, 2019.
3	R1. Bill Hobbs, Zach Schleien, "Hacking the Internship Process (Work)", La Plata Press, Paperback, 2017.

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

High-3, Medium-2, Low-1

Semester: IV		
Additional Mathematics-II (Common to all branches)		
Course Code:	MVJ21MATDIP2	CIE Marks:50
Credits:	L:T:P:S: 4:0:0:0	SEE Marks: 50
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To familiarize the important concepts of linear algebra.	
2	Aims to provide essential concepts differential calculus, beta and gamma functions.	
3	Introductory concepts of three-dimensional geometry along with methods to solve them.	
4	Linear differential equations	
5	Formation of partial differential equations.	

UNIT-I	
Linear Algebra: Introduction - Rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Diagonalization of a square matrix of order two. **Self study**: Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix-Examples. **Video Link**: 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs
UNIT-II	
Differential calculus: Indeterminate forms: L-Hospital rule (without proof), Total derivatives, and Composite functions. Maxima and minima for a function of two variables. **Beta and Gamma functions:** Beta and Gamma functions, Relation between Beta and Gamma function-simple problems. **Self study**: Curve tracing. **Video Link**: 1. http://nptel.ac.in/courses.php?disciplineID=111	8Hrs
UNIT-III	
Analytical solid geometry : Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- differentforms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems. **Self study**: Volume tetrahedron. **Video Link**: 1. http://nptel.ac.in/courses.php?disciplineID=111	8Hrs
UNIT-IV	
Differential Equations of higher order: Linear differential equations of second and higher order equations with constant coefficients. Inverse Differential	8 Hrs

operator, Operators methods for finding particular integrals , and Euler – Cauchy equation. **Self study**: Method of variation of parameters **Video Link**: 1. http://nptel.ac.in/courses.php?disciplineID=111	
UNIT-V	
Partial differential equation: Introduction- Classification of partial differential equations, formation of partial differential equations. Method of elimination of arbitrary constants and functions. Solutions of non-homogeneous partial differential equations by direct integration. Solution of Lagrange's linear PDE. **Self study**: One dimensional heat and wave equations and solutions by the method of separable of variable **Video Link**: 1. http://nptel.ac.in/courses.php?disciplineID=111	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Make use of matrix theory for solving system of linear equations and compute eigenvalues and eigen vectors required for matrix diagonalization process.
CO2	Learn the notion of partial differentiation to calculate rates of change of multivariate functions and solve problems related to composite functions and Jacobians.
CO3	Understand the Three-Dimensional geometry basic, Equation of line in space-different forms, Angle between two line and studying the shortest distance .
CO4	Demonstrate various physical models through higher order differential equations and solve such linear ordinary differential equations.
CO5	Construct a variety of partial differential equations and solution by exact methods.

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

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

Semester End Examination (SEE):
Total marks: 50+50=100

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

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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