VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Semester-I

Scheme of Teaching and Examinations and Syllabus

M. Tech., Machine Design (UMD)

(Effective from the Academic year 2022-23)

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M. Tech., Machine Design (UMD)-UNIVERSITY
Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC	22UMD11	Mathematical Methods in Engineering	03	00	00	03	50	50	100	3
2	IPCC	22UMD12	Analysis and Synthesis of Mechanisms	03	02	00	03	50	50	100	4
3	PCC	22UMD13	Vibration and Condition Monitoring	03	00	02	03	50	50	100	4
4	PCC	22UMD14	Non-Destructive Evaluation	02	00	02	03	50	50	100	3
5	PCC	22UMD15	Advanced Mechanics of Solids	02	00	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	00	00	03	50	50	100	3
7	PCCL	22UMDL17	Numerical Simulations Laboratory	01	02	00	03	50	50	100	2
8	AUD/ AEC	22AUD18/ 22AEC18	BoS recommended ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
			TOTAL	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course, AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BoS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses is impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyse and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

MATHEMATICAL METHODS IN ENGINEERING			
Course Code	**22UMD11**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Know how to Model and Solve, Ordinary Differential Equations of First and Second Order.
2. Understand Linear Algebra and its Applications.
3. Apply the Calculus of Variation for Engineering Applications
4. Use the Methods of Complex Analysis for Engineering

MODULE-1 (9 Hours)

First-Order ODEs: Basic Concepts - Modeling, Concept of Solution, Initial Value Problem, Geometric Meaning of Direction Fields, Euler's Method, Separable ODEs.

Second-Order Linear ODEs: Homogeneous Linear ODEs with Constant Coefficients, Modeling of Free Oscillations of a Mass–Spring System, Nonhomogeneous ODEs, Modeling: Forced Oscillations. Resonance. Modeling: Electric Circuits. Solving the ODE for the Current in an RLC-Circuit.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-2 (9 Hours)

Partial Differential Equations: Basic Concepts of PDEs, Modeling: Vibrating String (Wave Equation), Solution by Separating Variables, D'Alembert's Solution of the Wave Equation and Characteristics, Modeling: Heat Flow from a Body in Space (Heat Equation), Heat Equation: Solution by Fourier Series.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-3 (7 Hours)

Linear Algebra: Matrices, Vectors, Matrix Multiplication, Linear Systems of Equations, Gauss Elimination, Linear Independence. Rank of a Matrix. Vector Space, Solutions of Linear Systems:

Existence, Uniqueness, Determinants. Cramer's Rule, Inverse of a Matrix. Gauss–Jordan Elimination, Determining, Eigenvalues and Eigenvectors, Some Applications of Eigenvalue Problems.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-4 (8 Hours)

Complex Numbers, Functions and Differentiation: Geometric Representation, Polar Form of Complex Numbers, Powers and Roots, Analytic Function, Cauchy–Riemann Equations, Exponential Function, Trigonometric and Hyperbolic Functions.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-5 (7 Hours)

Calculus of Variation: Introduction, Examples of Simple Functionals, The first Variation (Euler - Lagrange Equation), The Delta operator,Geodesics and hanging chain problem.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons. 2011
2. Door Irving Herman Shames, Clive L. Dym , "Energy and Finite Element Methods in Structural Mechanics", 1st Edition, 2015 Reprint, New Age International.

Web links and Video Lectures (e-Resources):

1. Differential Equations for Engineers https://archive.nptel.ac.in/courses/111/106/111106100/
2. Ordinary and Partial Differential Equations and Applicationshttps://onlinecourses.nptel.ac.in/noc22_ma02/preview

Skill Development Activities Suggested

1. Solve an ODE using the MATLAB function ODE45 and obtain the graphical solution
2. Model a Spring-Mass- Damper system in MATLAB / SCILAB or in any similar software

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Model and find the solutions for First Order and Second Order ODEs	3
CO2	Solve the system of Linear Equations using Gauss Elimination and Cramer's rule	3
CO3	Apply the concepts of complex number theory	3
CO4	Generate and find solutions to Functionals.	3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	1
2	Students should be able to design, synthesize and analyse a physical engineering systems using modern tools and techniques.	4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1	**3**			**2**	
CO2	**3**			**2**	
CO3	**3**			**2**	
CO4	**3**			**2**	

Note : High - 1, Medium – 2, and Low – 3

ANALYSIS AND SYNTHESIS OF MECHANISMS			
Course Code	**22UMD12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab Sessions	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

This course will enable students to

1. Know the concepts used for kinematic analysis of planar and spatial mechanisms.
2. Familiarize with the concepts of force analysis and synthesis of mechanisms.

MODULE-1 (8 Hours)

Introduction: Elements of Mechanisms, degrees of freedom, Kutchback equation and Grublers criterion -applications of Grublers criterion, transmission angles- extreme values of transmission angles, toggle positions.

Path Curvature Theory: Introduction, fixed and moving centrodes, inflection points and inflection circle, Euler Savary Equation, Bobilliers Construction, Collineation axis, Bobillier theorem, Hartmann construction, Bresse circle, Return circle, Cusp Points, Crunode points.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-2(8 Hours)

Kinematic Synthesis: Introduction, type, dimensional and number Synthesis, synthesis for function generation, path and motion generation, Chebyschev Spacing of accuracy points Graphical Synthesis Techniques: Motion generation for two prescribed positions and three prescribed positions – path generation for three prescribed positions without and with prescribed timing – function generation for three prescribed positions.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-3 (8 Hours)

Graphical Synthesis Techniques: Motion generation for two prescribed positions and three prescribed positions – path generation for three prescribed positions without and with prescribed timing – function generation for three prescribed positions.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-4 (8 Hours)

Analytical Synthesis Techniques: Four bar and slider crank function generator with three accuracy points– use of complex numbers and dyads – three prescribed positions for motion, path and function generation using dyad.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-5 (8 Hours)

Spatial Mechanisms: D-H transformation matrix; forward kinematic analysis of serial manipulators– Reverse kinematic analysis – iterative solution techniques.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

PRACTICAL COMPONENT OF IPCC

Sl.NO.	Experiments
1	Basics of Kinematic/ Multi-body Simulation Software: Falling Stone, Inclined Plane, Lift Mechanism
2	One-degree-of-freedom Pendulum, Projectile Motion, Spring Damper
3	Suspension System , Four Bar Velocity
4	Cam-Follower, Crank Slider
5	Valve-train Mechanism, Cam-rocker-valve
6	Stamping Mechanism, Robot Arm
7	Adams Optimization, Airplane Control Surface
8	Gyroscope and Power Hacksaw Mechanism
	Demonstration Experiments (For CIE)
9	Walking Beam Indexer
10	Watt's Linkage in a Steam Engine
11	Open Differential
12	Planetary Gear Sets Modification
Books:Adams Tutorial Kit for Mechanical Engineering Courses	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

- Two Tests each of **20 Marks**
- Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
- Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component)

Suggested Learning Resources:

Books

1. Uicker, Pennock and Shigley," Theory of machines and Mechanisms", Oxford University Press, 2010.
2. Amitabha Ghosh and Ashok Kumar Mallik, "Theory of Mechanism and machines", East West Press pvt Ltd, 2nd edition.
3. S.S. Rattan, "Theory of Machines", Tata McGraw Hill, 2011.

Web links and Video Lectures (e-Resources):

1. NOC:Kinematics of Mechanisms and Machines, IIT Kharagpur https://nptel.ac.in/courses/112105268
2. Kinematics Of Machineshttps://www.youtube.com/watch?v=MJeRFzs4oRU&list=RDCMUC640y4UvDAlya_WOj5U4pfA&index=2

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Write a MATLAB Program for kinematic analysis of Fourbar mechanism
2. Write a program in MATLAB to simulate the forward kinematics of a 2R Robotic Arm.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply path curvature characteristics in analysis of mechanisms.	3
CO2	Apply analytical and synthesis techniques in design of mechanisms.	4
CO3	Apply forward and reverse kinematic analysis techniques in performance evaluation of manipulators	3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	1
2	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	3
3	Students should be able to design, synthesize and analyse a physical engineering systems using modern tools and techniques.	4
4	Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions.	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**-**	**1**	**2**	**1**
CO2	**3**	**-**	**1**	**1**	**2**
CO3	**3**	**-**	**1**	**3**	**2**

Note : High - 1, Medium – 2, and Low – 3

VIBRATION AND CONDITION MONITORING			
Course Code	**22UMD13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40+ 10-12 Activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

1. To study the basic concepts of vibration.
2. To characterize the free and forced vibrations of damped and undamped single degree of freedom systems.
3. To understand the transient vibration response of a single degree of freedom system.
4. To study various vibration measuring instruments.
5. To study and characterize the random vibrations.
6. To characterize the continuous systems.
7. To study the basic principles of maintenance and condition monitoring.

MODULE-1(9 Hours)

Introduction: Elements of vibratory system, examples of vibratory motions, simple harmonic motion, degrees of freedom.

System with One Degree of Freedom: Equations of motion by Newton's method & Energy method, general solution, frequency response method. Undamped free vibration and damped free vibration.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-2(9 Hours)

Forced Vibration of Single Degree of Freedom System: Undamped forced vibration – harmonic excitation, damped forced vibration – harmonic excitation, rotating and reciprocating unbalance, vibration isolation and transmissibility, system attached to moving support.

Transient Vibration of Single Degree of Freedom System: Introduction, Derivation of Convolution Integral – response due to unit impulse, Response due to a General Excitation, Excitations Whose Forms Change at Discrete Times, Transient Motion Due to Base Excitation, Laplace Transform Solutions, Transfer Functions, Numerical Methods, Shock Spectrum, Vibration Isolation for Short Duration Pulses.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-3(7 Hours)

Vibration Measurements: Introduction, transducers, vibration measuring instruments – vibrometers and accelerometers, frequency measuring instruments, vibration exciters, signal analysis.

Random Vibrations: Introduction, random variables and random processes, probability distribution, mean value and standard deviation, correlation functions of a random process, stationary random process, Gaussian random process, Fourier transforms and response, power spectral density.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-4(8 Hours)

Continuous Systems: Introduction, continuous system – a simple exposition, separation of time and space variables, problems governed by wave equation: longitudinal vibrations of rods & torsional vibration of shaft, lateral vibration of beams.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-5(7 Hours)

Condition Monitoring:

Principles of Maintenance: Introduction, reactive maintenance, preventive maintenance, predictive maintenance, bath tub curve, failure modes effect and criticality analysis.

Vibration Monitoring: Principles of vibration monitoring, misalignment detection, eccentricity detection, cracked shaft, bowed and bent shaft, unbalanced shaft, looseness, rub, bearing defects, gear fault, faults in fluid machines and rotating machines.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Francis S. Tse, Ivan E. Morse, Rolland T. Hinkle, "Mechanical Vibrations - Theory and Applications", Allyn and Bacon, Inc., 2004, ISBN-10: 8123908466 / ISBN-13: 978-8123908465.
2. S. Graham Kelly, "Mechanical Vibrations – Thoery and Applications", Cengage Learning, 2012, ISBN-10: 1-4390-6214-5 / ISBN-13: 978-1-4390-6214-2.
3. Amiya R. Mohanty, "Machinery Condition Monitoring", CRC Press, 2015, ISBN-13: 978-1-4665-9305-3.

Web links and Video Lectures (e-Resources):

1. NOC:Introduction to Mechanical Vibration, IIT Roorkee (https://nptel.ac.in/courses/112107212)
2. Mechanical Vibrations, IIT Guwahati (https://nptel.ac.in/courses/112103112)
3. http://va-coep.vlabs.ac.in/List%20of%20experiments.html

Skill Development Activities Suggested

1. Write MATLAB/ SCILAB programs to simulate the response of single degree of freedom systems under free and forced vibrations.
2. To create mathematical models of single degree of freedom systems in MATLAB Simulink / SCILAB.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss the basics of vibrations and determine the equations of motion for free & forced vibrations of single degree of freedom systems and to find their solution	3
CO2	Determine the response of a single degree of freedom system subjected to various types of input forces.	3
CO3	Apply fundamentals of vibrations to its measurement and analysis	3
CO4	Determine the equations of motion for continuous system and to find their solutions.	3
CO5	Discuss and apply these concepts for condition monitoring of machines	3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	1
2	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	3
3	Students should be able to design, synthesize and analyse a physical engineering systems using modern tools and techniques.	4
4	Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions.	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1	**3**		**1**	**3**	**2**
CO2	**3**		**1**	**2**	**1**
CO3	**3**		**1**	**3**	**2**
CO4	**2**		**1**	**3**	**1**
CO5	**1**		**1**	**2**	**2**

Note : High - 1, Medium – 2, and Low – 3

NON-DESTRUCTIVE EVALUATION			
Course Code	**22UMD14**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 + 10-12 Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To introduce basic principles, techniques and equipment needed for various non-destructive testing(NDT) methods viz. visual, penetrant testing, magnetic particle testing, eddy current testing, radiography, ultrasonic testing, acoustic emission testing, thermography, leak testing.
2. To enable selection of appropriate NDT methods.
3. To identify advantages, disadvantages and limitations of various NDT methods.
4. To understand standards used for various NDT methods.

MODULE-1(5 Hours)

Introduction: Overview of NDT, NDT vs destructive testing. **Visual Inspection:** Basic principle, unaided visual inspection, visual inspection with optical aids.

Liquid Penetrant Testing: Physical principles, procedure, penetrant testing materials, penetrant testing methods, sensitivity, applications and limitations, standards.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-2 (5 Hours)

Magnetic Particle Testing: Magnetism – basic definitions and principle of MPT, magnetizing techniques, MPT procedure, equipment required for MPT, sensitivity, limitations, standards.

Eddy Current Testing: Principles, instrumentation for ECT, techniques, sensitivity, advanced eddy current test methods, applications, limitations, standards.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-3 (5 Hours)

Radiography: Basic principle, electromagnetic radiation sources, radiation attenuation in the specimen, effect of radiation on film, radiographic imaging, inspection techniques, applications of radiographic inspection, limitations. Real time radiography, microfocal radiography, safety in industrial radiography, standards, neutron radiography.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-4 (4 Hours)

Ultrasonic Testing: Basic properties of sound beam, ultrasonic transducers, inspection methods, techniques for normal beam inspection, techniques for angle beam inspection, flaw characterization techniques, ultrasonic flaw detection equipment, modes of display – A scan / B scan / C scan, immersion testing, applications of ultrasonic testing, advantages, limitations, standards, mechanical impedance analysis techniques.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-5 (6 Hours)

Acoustic Emission Testing: Principle of AET, technique, instrumentation, sensitivity, applications, standards, structural integrity assessment, acoustic emission technique for leak detection. **Thermography:** Basic principles, detectors and equipment, techniques, applications, codes and standards. **Leak Testing:** Measurement of leakage, leak testing methods, leak detection, standards.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu, "Practical Non-Destructive Testing", Navosa Publishing House, 2009, ISBN-10: 8173197970 / ISBN-13: 978-8173197970.
2. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Private Limited, 2010, ISBN-10: 8122425887 / ISBN-13: 978-8122425888.
3. American Society of Metals, ASM Metals Handbook, "NonDestructive Evaluation and Quality Control", Volume-17, Metals Park, Ohio, USA, 2018, ISBN-13: 978-1-62708-152-8.

Web links and Video Lectures (e-Resources):

1. NOC:Theory and Practice of Non Destructive Testing, IIT Madras (https://nptel.ac.in/courses/113106070)

Skill Development Activities Suggested

1. Industrial visit / internship to gain hands-on experience on various non-destructive testing methods.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Classify various NDT methods.	2
CO2	Explain and perform various non-destructive tests viz. visual, penetrant testing, magnetic particle testing, eddy current testing, radiography, ultrasonic testing, acoustic emission testing, thermography, leak testing.	2
CO3	Identify defects using relevant NDT methods.	3
CO4	Explain the standards for various NDT methods.	2

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems.	1
2		
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	3
4	Students should be able to design, synthesize and analyse a physical engineering systems using modern tools and techniques.	4
5	Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions.	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1			**1**	**2**	**2**
CO2			**1**	**3**	**3**
CO3	**3**		**1**	**2**	**2**
CO4	**3**		**1**	**2**	**2**

Note : High - 1, Medium – 2, and Low – 3

ADVANCED MECHANICS OF SOLIDS			
Course Code	**22UMD15**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 + 10-12 Activities	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To familiarize with the concepts of stresses and strains in un symmetric bending and torsion using classical methods.
2. To be conversant with the concept of energy methods applied in elasticity.

MODULE-1 (5 Hours)

Theories of Stress: The state of stress at a point, normal and shear stress components, rectangular stress components,stress components on an arbitrary plane, principal stresses octahedral stress. Equilibrium equations for plane stress state,boundary condition.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-2 (5 Hours)

Theories of Strain: deformation, deformation in the neighbourhood of a point, change in length of a linear element, change in length of linear element – linear components, change in direction of linear elements, change in the angle between two line elements.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-3(5 Hours)

Stress–Strain Relations &Energy Methods: Generalised statement of hook's law , stress – strain relation for isotropic materials, relation between the elastic constants, initiation of yield, yield criteria, The principle of superposition, work done by forces and elastic strain energy stored, reciprocal relation. Maxwell-Betti-Rayleigh reciprocal theorem, superposition of elastic energies.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-4 (5 Hours)

Axisymmetric Problems: Thick – walled cylinder subjected to internal and external pressure, stresses due togravitation, rotating disk of uniform thickness, disk of variable thickness rotating cylinders.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

MODULE-5 (5 Hours)

Linear elastic solutions: Prandtl elastic membrane (Soap-Film) analogy, narrow rectangular cross section, hollow thin walltorsion members, multiple connected cross sections. Hollow thin wall torsion members, Thin wall torsion members withrestrained ends.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk are used for Problem Solving, Laboratory Demonstrations and Practical Experiments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

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Suggested Learning Resources:

Books

1. Boresi& Sidebottom, "Advanced Mechanics of materials" Wiely International, 6th edition.
2. Dr Sadhu Singh, "Strength of materials" Khanna Publication, 1st edition
3. Timoshenko S. P. and Goodier J. N., "Theory of elasticity", McGraw- Hill Publishers, 3rd Edition.
4. L. S. Srinath, "Advanced Mechanics of Solids", McGraw Hill Education (India) Pvt. Ltd., 3rd edition

Web links and Video Lectures (e-Resources):

1. Advanced Solid Mechanics: https://archive.nptel.ac.in/content/storage2/courses/105106049/lecnotes/main.html
2. NOC:Solid Mechanics, IIT Delhi : https://nptel.ac.in/courses/112102284
3. Advanced Strength of Materials, IIT Bombay :https://nptel.ac.in/courses/112101095

Skill Development Activities Suggested

1. Use the tensor notation to represent the equations for Elasticity
2. Find the stress concentration factors from FEM and copare with elastic solutions
3. Explore the technique of image processing to estimate the surface strains on a loaded body.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply the theory of elasticity including strain/displacement and Hooke's Law relationships.	3
CO2	Solve for stresses and deflection beam under unsymmetrical loading	3
CO3	Solve torsion problems in bars and thin walled methods.	3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems.	1
2	Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions.	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**--**			**3**
CO2	**3**	**-**			**2**
CO3	**3**	**-**			**3**

RESEARCH METHODOLOGY AND IPR			
Course Code	**22RMI16**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights

MODULE-1(10 Hours)

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. 10Hrs

Teaching-Learning Process	Power-point Presentation, Chalk and Talk are used for Problem Solving,

MODULE-2(10 Hours)

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. 10Hrs

Teaching-Learning Process	Power-point Presentation, Chalk and Talk are used for Problem Solving,

MODULE-3(10 Hours)

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. 10Hrs

Teaching-Learning Process	Power-point Presentation, Chalk and Talk are used for Problem Solving,

MODULE-4(10 Hours)

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. 10Hrs

Teaching-Learning Process	Power-point Presentation, Chalk and Talk are used for Problem Solving,

MODULE-5(10 Hours)

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers‟ Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation(WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules,Patents,Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the RightHolder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.10Hrs

Teaching-Learning Process	Power-point Presentation, Chalk and Talk are used for Problem Solving,

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. C.R. Kothari, Gaurav Garg, "Research Methodology: Methods and Techniques", New Age International, 4th Edition, 2018.
2. Ranjit Kumar, "Research Methodology a step-by-step guide for beginners", SAGE Publications, 3rd Edition, 2011 (For the topicReviewing the literature under module 2)
3. Study Material - Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries ofIndia, Statutory Body Under an Act of Parliament, September 2013. (For the topic Intellectual Property under module 5)
4. William M. K. Trochim ; 1st Edition, illustrated ; Publisher, Atomic Dog Pub., 2005
5. Fink A, "Conducting Research Literature Reviews: From the Internet to Paper", Sage Publications, 20112009.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/127/106/127106227/
- https://www.youtube.com/watch?v=GSeeyJVD0JU

Skill Development Activities Suggested

1. Skill Development Activities Suggested:
2. Interact with industry (small, medium, and large).
3. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
4. Involve in case studies and field visits/ fieldwork.
5. to the use of standards/codes etc., to narrow the gap between academia and industry.
6. Handle advanced instruments to enhance technical talent.
7. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
8. Accustom Work on different software/s (tools) to simulate, analyse and authenticate the output to interpret and conclude.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem	2
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review	2
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	2
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	2
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR	2

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems.	1
2	An ability to write and present a substantial technical report/document.	2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	3
4	Students should be able to design, synthesize and analyse a physical engineering systems using modern tools and techniques.	4
5	Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions.	5

Mapping of COS and POs (indicative only)

	PO1	PO2	PO3	PO4	PO5
CO1	**1**	**1**	**1**	**3**	**1**
CO2	**1**	**1**	**2**	**3**	**1**
CO3	**1**	**1**	**3**	**3**	**3**
CO4	**1**	**1**	**2**	**3**	**3**
CO5	**1**	**1**	**3**	**2**	**3**

Note : High - 1, Medium – 2, and Low – 3

NUMERICAL SIMULATIONS LABORATORY			
Course Code	**22UMDL17**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Total Hours of Pedagogy	15 + 10 -12 Laboratory Sessions	Total Marks	100
Credits	2	Exam Hours	3

Course objectives:

- To familiarize the students with a Scientific Computing Software such as MATLAB/SCILAB/PYTHON
- To Solve ODEs and other mathematical problems numerically.

Sl.NO	EXPERIMENTS
1	Introduction to MATLAB/SCILAB 1: Basics, Creating Arrays,
2	Introduction to MATLAB/SCILAB 2: Mathematical Operations, Script Files, 2D and 3D Plots, Functions and Programming. Applications
3	Introduction to MATLAB/SCILAB 3: 2D and 3D Plots, Functions and Programming. Applications
4	Solve the First Order Differential Equation: $\frac{dy}{dt} = \frac{t^3-2y}{t} for\ 1 < t < 3\ and\ y = 4.2\ at\ t =$ 1using MATLAB and plot the solution
5	Solve a Second-Order Differential Equation Numerically: $\frac{d^2y}{dx^2} = (1-y^2)\frac{dy}{dx} - y$using MATLAB and plot the solution.
6	Python Basics 1: Basics, Flow Control, Functions, Lists, Dictionaries, String Manipulation.
7	Python Basics 2: Pattern Matching, Reading & Writing Files, Organising files and Debugging
8	Python Basics 3: Web Scraping, Working with Excel and Google Spread Sheets.
	DEMONSTRATION EXPERIMENTS (FOR CIE)
9	Write a MATLAB Code for solving ODEs using approximate Method of weighted residuals differential equations (y"+y-4*x=0) and (y'+y=1, for y(0)=1, y(1)=0) using four methods: Point Collocation, Sub Domain, Least Squares, and Galerkin's. Compare the results with one another and with exact solution.
10	Solve in MATLAB/SCILAB Using Variational Method (Ritz Method) : $-\frac{d^2y}{dx^2} - y + x^2 for\ 0 < x < 1\ with\ boundary\ conidtions: y(0) = 0\ and\ y(1) = 0$
11	Write a MATLAB code for solving 2nd-order homogeneous, constantcoefficients BVPs via Galerkin's Method over " n" elements:
12	Write a python program function *gaussQuad2* that computes $\iint_A f(x,y)dx\,dy$ over a quadrilateral element with Gauss-Legendre quadrature of integration order m.

Course outcomes (Course Skill Set):

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

- Model simple to complicated kinematic systems independently
- Analyse and interpret the commonly occurring kinematic systems in a commercial software
- Verify the results of simulations of a commercial software with Analytical Methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

1. Amos Gilat, MATLAB, An Introduction with Applications, John Wiley & Sons, 4th Edition or later, 2011
2. Achuthsankar S Nair, SCILAB (A Free Software To MATLAB), S Chand Publishing, 2012
3. https://www.scilab.org/about/community/books
4. https://www.mathworks.com
5. https://www.python.org/
6. Al Sweigart, "Automate the Boring Stuff with Python: Practical Programming for Total Beginners", No Starch Press, (https://automatetheboringstuff.com/)
7. JaanKiusalaas, Numerical Methods in Engineering with Python 3, Cambridge University Press, 2013
8. https://in.mathworks.com/help/symbolic/solve-a-single-differential-equation.html
9. https://in.mathworks.com/help/symbolic/solve-differential-equation-numerically-1.html
10. Angwenyi David Variational Methods: The Ritz Method (https://www.mathworks.com/matlabcentral/fileexchange/102599-variational-methods-the-ritz-method), MATLAB Central File Exchange. Retrieved November 12, 2022..
11. https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin's_Method_over_ne_elements/link/5ad4321aa6fdcc29357ffa67/download
12. MATLAB code for solving 2nd-order homogeneous, constant coefficients BVPs via Galerkin's Method over "n_e" elements: https://www.researchgate.net/publication/324536698_A_lecture_note_on_MATLAB_code_for_solving_2_nd-order_homogeneous_constant_coefficients_BVPs_via_Galerkin%27s_Method_over_ne_elements
13. https://in.mathworks.com/matlabcentral/fileexchange/79667-method-of-mean-weighted-residuals-example
14. https://in.mathworks.com/matlabcentral/fileexchange/79068-weighted-residue-method-for-bar-problem
15. https://www.me.ua.edu/me611/f02/pdf/mwr.pdf