Semester- II

ADVANCED MACHINE DESIGN			
Course Code	**MMEA201**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

- Outline the basic philosophy of machine design
- Compute the required load under various practical conditions
- Apply the various static load based theories of failures
- Apply the various fatigue load based theories of failures

Module-1

Introduction to Mechanical Engineering Design: Design and Mechanical Engineering Design, Phases and Interactions of the Design Process, Design Tools and Resources, The Design Engineer's Professional Responsibilities, Standards and Codes, Stress and Strength, Design Factor and Factor of Safety, Reliability, Dimensions and Tolerances, Calculations and Significant Figures.

Module-2

Load Determination: Loading Classes, FBDs, Load Analysis, 2D Static Loading Case Studies, 3D Static Loading Case Studies, Impact Loading, Beam Loading.

Module-3

Stress and Strain: Stress, Strain, Principal Stress, Plane Stress and Plane Strain, Mohr's Circle, Applied Versus Principal Stresses, Axial Tension, Direct Shear Stress, Bearing Stress and Tear-out.

Module-4

Deflection: Beams and Bending Stresses, Deflection in Beams, Torsion, Combined Stresses, Spring Rates, Stress Concentration, Stresses in Cylinders, Case Studies In Static Stress And Deflection Analysis.

Module-5

Static Failure Theories: Failure of Ductile Materials, Failure of Brittle Materials, Case Studies: Bicycle Brake Lever, Crimping Tool, Automobile Scissors- jack, Bicycle Brake Arm.

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:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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.

Suggested Learning Resources:

Books

1. Robert L. Norton, Machine design - An Integrated Approach, 4th Edition, Prentice- Hall, 201.
2. R G Budynas, and J K Nisbett, Shigley's Mechanical Engineering Design, 9th Edition, McGraw Hill,2011

Web links and Video Lectures (e-Resources):

- https://www.machinedesign.com/
- https://archive.nptel.ac.in/courses/112/105/112105125/
- https://archive.nptel.ac.in/courses/112/105/112105124/

Skill Development Activities Suggested

- Write a small C Program to design a shaft for both static and dynamic loading
- Compute the fatigue life of simple rod subject to constant amplitude load in a commercial Software
- Learn the usage of MSC Fatigue Module of NASTRAN

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Define basic philosophies used in Machine Design	2
CO2	Design and Analyse any geometrically well-defined component subjected to static loading	4

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.	3
4	Students should be able to design, synthesize and analyze 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	**3**	**3**	**1**	**1**	**1**
CO2	**3**	**2**	**1**	**3**	**1**
CO3	**3**	**2**	**1**	**2**	**1**

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

Semester - II

ADVANCED FINITE ELEMENT METHODS AND APPLICATIONS			
Course Code	**MMEA202**	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 slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

1. Introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
2. Discuss the use of finite element methods in engineering problem-solving drawing from applications in solid mechanics and other engineering Domains.
3. Familiarize students with professional-level finite element software.
4. To define, derive and assemble stiffness matrices for spring element, truss element, beam elements, Plane Stress element.
5. To be familiar with the idea of Isoparametric formulation for various FE Elements
6. FE Formulation of Axisymmetric and Solid Elements.

MODULE-1

Mathematical Preliminaries: Principle of Virtual Work, General steps of the Finite Element Method.

Introduction to the Stiffness (Displacement) Method: Definition of the Stiffness Matrix, Derivation of the Stiffness Matrix for a Spring Element, Example of a Spring Assemblage, Assembling the total Stiffness Matrix by Superposition Method, Boundary Conditions, Potential Energy Approach to Derive Spring Element Equations.

MODULE-2

Development of Truss Equations: Derivation of the Stiffness Matrix for a Bar Element in Local Coordinates, Selecting a Displacement Function, Transformation of vectors in Two Dimensions, Global Stiffness Matrix for Bar Arbitrarily Oriented in the Plane, Computation of Stress for a Bar in the x – y Plane, Solution of a Plane Truss, Transformation Matrix and Stiffness Matrix for a Bar in three-Dimensional space, Use of symmetry in Structures, Inclined Supports, Potential Energy Approach to Derive Bar Element Equations, Galerkin's Residual Method and its Use to Derive the One-Dimensional Bar Element Equations, Other Residual Methods and their application to a One-Dimensional bar problem

MODULE-3

Development of Beam Equations: Beam stiffness, Example of Assemblage of Beam Stiffness Matrices, Examples of Beam analysis Using the Direct stiffness Method, Distributed Loading, Beam Element with Nodal Hinge, Potential Energy Approach to Derive Beam Element Equations, Galerkin's Method for Deriving Beam Element Equations.

MODULE-4

Development of the Plane Stress and Plane Strain Stiffness Equations: Basic Concepts of Plane Stress and Plane Strain, Derivation of the Constant-Strain triangular Element Stiffness Matrix and Equations, Treatment of body and Surface Forces, Explicit Expression for the Constant-Strain Triangle Stiffness Matrix, Finite Element Solution of a Plane Stress Problem, Rectangular Plane Element (bilinear rectangle, Q4). **Development of the Linear Strain Triangle Equations**: Derivation of the Linear-Strain Triangular Element Stiffness Matrix and Equations, Example LST Stiffness Determination, Comparison of Elements. **Axisymmetric Elements:** Derivation of the stiffness Matrix, Solution of an Axisymmetric pressure vessel.
MODULE 5
Isoparametric Formulation: Isoparametric Formulation of the Bar Element Stiffness Matrix, Isoparametric Formulation of the plane Quadrilateral (Q4) Element Stiffness Matrix, Newton-Cotes and Gaussian Quadrature, Evaluation of the Stiffness Matrix and Stress Matrix by GaussianQuadrature, Higher-Order Shape Functions (including Q6, Q8,Q9, and Q12 Elements). **Three-Dimensional Stress Analysis:** Three-Dimensional Stress and Strain, Tetrahedral element, Isoparametric Formulation and Hexahedral element.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl. NO	Experiments
1	Solve (with MATLAB), the ODE using the weak formulation (FEM/MATLAB): $a\ (d^2u/dx^2)$ + $b\ (du/dx) + cu = f(x)$, $0 < x < L$ *with Boundary Conditions*: $u(0) = 0$ *and* $u(L) = 0$ take a=1, b=-3, c=2 and f(x)=1. Take domain size as 1 (i.e. L=1) and take Five linear elements of equal size.
2	Solve (with MATLAB), the ODE using the weak formulation (FEM/MATLAB): $a\ (d^2u/dx^2)$ + $b\ (du/dx) + cu = f(x)$, $0 < x < L$ *with Boundary Conditions*: $u(0) = 0$ *and* $du/dx\ (1) = 0$ take a=1,b=-3, c=2 and f(x)=1. Take domain size as 1(i.e. L=1) and take Five linear elements of equal size.
3	Solve using MATLAB, the Laplace equation representing two dimensional steady-state problems using both linear triangle elements with the given boundary conditions: $(\partial^2u/\partial x^2) + (\partial^2u/\partial y^2) = 0$ *for* $0 < x < 5$ *and* $0 < y < 10$. The boundary conditions are u(x, 0) =0 for 0<x<5, u(0,y)=0 for 0<y<10, u(x,10)=100sin(ϖx/10) for 0<x<5, and $[\partial u(5,y)] / \partial x$ =0 for 0<y<10.
4	Solve the problem 3 using the bilinear rectangular elements with other conditions remaining same.
5	Write a MATLAB program to Use Gauss-Legendre quadrature for integration of $f(x, y) = 1 + 4xy - 3x^2y^2 + x^4y^6$ over the domain -1<x<1 and -1<y<1. Use 3-point quadrature rule along the x-axis and 4-point quadrature rule along y-axis.
6	Determine the natural frequency of a free bar (Fixed at one end and free at other) using the finite element method. The bar has Young's Modulus of 200 GPa, Cross-sectional area of 0.001 m^2 , Density of 7860 Kg/m^3 and Length of 4 m.
7	Write a MATLAB program to perform stress analysis of a cantilever beam subjected to end load using two dimensional Isoparametric elements assuming plane stress condition. Model the beam using ten four-node quadrilateral elements.

8	Write a generalised MATLAB Code that can solve any two dimensional truss structure to find member forces.
9	Make a report of available 1D, 2D and 3D Elements in a commercial FE Software.
10	Make a report of the practical aspects to be considered while generating a mesh in commercial software.
Demonstration Experiments	
11	Solve a problem of a Cantilever beam subjected to end point load in a commercial software to find out its displacements and stresses
12	Write a script in commercial software to automate the above problem for various dimensions and material properties.

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

1. Two Tests each of **25 Marks**

2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. 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 experimentsshall 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**.

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SEE for IPCC

Theory SEE will be conducted by the University as per the scheduled timetable, with common

question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. 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.
4. 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).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources:

Books

1. Daryl L. Logan, "A First Course in the Finite Element Method", 6th Edition, Cengage Learning, 2017.
2. Jacob Fish and Ted Belytschko, "A First Course in Finite Elements", John Wiley & Sons, 2007
3. J. N. Reddy, "An Introduction to the Finite Element Method", 3rd Edition, Mc-Graw Hill, 2006
4. Ferreira, Antonio & Fantuzzi, Nicholas., "MATLAB Codes for Finite Element Analysis: Solids and Structures", Springer, 2009.

Web links and Video Lectures (e-Resources):

1. NOC: Finite Element Method: Variational Methods to Computer Programming, IIT Guwahati (https://nptel.ac.in/courses/112103295)
2. NOC:Basics of Finite Element Analysis - II, IIT Kanpur (https://nptel.ac.in/courses/112104205)
3. Abaqus FEA Tutorial Videos (https://www.youtube.com/user/AbaqusPython)

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

1. Write MATLAB/ SCILAB programs to Analyse the 1D,2D, and 3D Finite Elements.
2. Practice the Modelling, Meshing, and Analysis of simple structures in commercial software and compare the results with closed form solutions.
3. Take an open source FE Software, Compile, and generate an executable file.
4. Understand and summarise the format of the input ASCII files generated by commercial meshing software for any well know FE Solver.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the Basis of formulation of Finite Element Methods	2
CO2	Formulate the complete FE Formulation for 1D, 2D, and 3D Elements	3
CO3	Evaluate various boundary conditions in the FE Application	5
CO4	Write a computer program to analyse a simple Truss structure	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	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

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

Semester- II

Optimization Techniques			
Course Code	MMEA203	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

- Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems.
- Learn classical optimization techniques and numerical methods of optimization.
- Know the basics of different evolutionary algorithms.
- Explain Integer programming techniques and apply different optimization techniques to solve various models arising from engineering areas

Module-1

Liner Programming (LP): Revised Simplex Method, Duel simplex Method, Sensitivity Analysis
Dynamic Programming (DP): Multistage decision processes. Concepts of sub optimization, Recursive Relation-calculus method, tabular method, LP as a case of D.P

Module-2

Classical Optimization Techniques: Single variable optimization without constraints,Multi variable optimization without constraints, multivariable optimization with constraints method of Lagrange multipliers, Kuhn-Tucker conditions.
Numerical Methods For Optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method.

Module-3

Modern methods of optimization:
Genetic Algorithm (GA): Differences and similarities between conventional and evolutionary algorithms, working principle, Genetic Operators- reproduction, crossover, mutation.

Module-4

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation.
Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems.

Module-5

Integer Programming: Graphical Representation, Gomory's Cutting Plane Method, Balas' Algorithm for Zero–One Programming, Branch-and-Bound Method.

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:

3. Two Unit Tests each of **25 Marks**
4. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Books

1. Singiresu S. Rao," Engineering Optimization Theory and Practice", 4th Edition, John Wiley, 2009
2. Kalyanmoy Deb,Optimization forEngineering Design Algorithms and Examples,2nd Edition, PHI Learning Private Limited, New Delhi, 2012
3. David E. Goldberg,"Genetic Algorithms in Search, Optimization and Machine Learning", Addison- Wesley Longman Publishing Co., Inc, 1989
4. Frederick Hillier and Gerald Lieberman, "Introduction to Operations Research", 11th Edition, Tata McGraw Hill, 2021.
5. Jasbir S. Arora, "Introduction to Optimum Design", McGraw - Hill College, 1988

Web links and Video Lectures (e-Resources):

- Optimization Toolbox (https://in.mathworks.com/products/optimization.html)
- S.N. Sivanandam, S.N. Deepa ,Principles of Soft Computing, 2nd Edition ,2011
- Principle of Soft computing (https://archive.nptel.ac.in/courses/106/105/106105173/)

Skill Development Activities Suggested

- One or two exercises of Optimization using MATLAB/Python.

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 fundamental knowledge of Linear Programming and Dynamic Programming problems.	3
CO2	Use classical optimization techniques and numerical methods of optimization.	3
CO3	Enumerate fundamentals of Integer programming technique and apply GA and Fuzzy techniques to solve various problems in engineering areas.	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	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

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

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

PROFESSIONAL ELECTIVE 3

Semester- 2

FRACTURE MECHANICS			
Course Code	MMEA214A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To discuss presence of various flaws in a body
- To study different methods of identifying them non-destructively
- To study the linear elastic fracture parameters such as Energy Release Rate and Stress Intensity Factor.
- Discuss the elasto-plastic fracture parameters such as CTOD and J-Integral

Module-1

Introduction to Fracture Mechanics: Kinds of Failure, Historical Aspects, Brittle and Ductile Fracture, Modes of Fracture Failure, How Potent is a Crack?, Point of View, Damage Tolerance.

Crack Detection through Non-Destructive Testing: Examination through Human Senses, Liquid Penetration Inspection, Ultrasonic Testing, Radiographic Imaging, Magnetic Particle Inspection.

Module-2

Energy Release Rate: Griffith's Dilemma, Surface Energy, Griffith's Realization, Griffith's Analysis, Energy Release Rate, Energy Release Rate of DCB Specimen, Anelastic Deformation at Crack-tip, Crack Resistance, Stable and Unstable Crack Growth, R-curve for Brittle Cracks, Thin Plate vs Thick Plate, Critical Energy Release Rate.

Module-3

Stress Intensity Factor: Stress and Displacement Fields in Isotropic Elastic Materials ,Stress Intensity Factor,Background for Mathematical Analysis, Westergaard's Approach-Model (Opening Mode),Mode II (Sliding Mode),Mode III (Tearing Mode).
SIF of More Complex Cases: Other Applications of Westergaard Approach, Application of the Principle of Superposition, Crack in a Plate of Finite Dimensions, Edge Cracks, Embedded Cracks, The Relation between GI and KI, Critical Stress Intensity Factor.

Module-4

Anelastic Deformation at the Crack Tip: Further Investigation at the Crack Tip Approximate Shape and Size of the Plastic Zone,Effective Crack Length-Approximate Approach,The Irwin Plastic Zone Correction, Plastic Zone Size through the Dugdale Approach. Effect of Plate Thickness.

J-Integral: Relevance and Scope, Definition of the J-Integral,Path Independence,Stress-Strain Relation, Further Discussion on J-Integral-From a Designer's Point of View,Experiments to Determine the CriticalJIntegral, Comments on the Numerical Evaluation ofJ-Integral,Predicting Safety or Failure,Comments on the Experimental Determination of the Toughness of Ductile Materials.

Module-5

Crack Tip Opening Displacement: Introduction, Relationship between CTOD, KI and GI for Small Scale Yielding, Equivalence between CTOD and J.

Test Methods :KIC-Test Technique, Test Methods to Determine JIC, Test Methods to Determine GIC and GIIC,Determination of Critical CTOD

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:

5. Two Unit Tests each of **25 Marks**
6. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

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

Suggested Learning Resources:

Books

1. Prashant Kumar, "Elements Of Fracture Mechanics", Tata McGraw-Hill Publishing Company Limited, 2009
2. T. L. Anderson," Fracture Mechanics: Fundamentals and Applications,",3rd Edition. CRC Press, 2005

Web links and Video Lectures (e-Resources):

- Introduction To Fracture Mechanics (https://ocw.mit.edu/courses/3-11-mechanics-of-materials-fall-1999/resources/mit3_11f99_frac/)
- Engineering Fracture Mechanics NPTEL (https://archive.nptel.ac.in/courses/112/106/112106065/

Skill Development Activities Suggested

- Learn to use fracture mechanics of software such as NASGRO (https://www.swri.org/consortia/nasgro), AFGROW (https://www.afgrow.net/), FRANC3D (https://franc3d.in/)
- Study the ASTM Standards used to find various Fracture Parameters
- Write code to simulate the fatigue growthby fracture as in NASGRO.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Compute elastic stress analysis of cracked bodies subjected to various static loading and determine the expression for displacement, stress and strain.	3
CO2	Determine the expression for stress intensity factors for mode I mode II and Mode III loading.	2
CO3	Evaluate fracture Toughness for metallic materials according to ASTM standard test methods.	3
CO4	Identify the elastic plastic fracture behaviour and fracture toughness values in terms R, J, and CTOD.	2
CO5	Outline fatigue crack growth behaviour and crack growth laws and design mechanical members and develop fracture control plan.	5

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	PO6	PO7	PO8	PO9	PO10
CO1	**1**				**1**					
CO2	**1**				**3**					
CO3	**1**				**1**					
CO4	**1**				**1**					
CO5	**1**				**1**					

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

Semester- 2

Fatigue and Failure Analysis			
Course Code	MMEA214B	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Introduce basic aspects of Fatigue and Failure.
2. Discuss the availability of various fatigue analysis methods that are used by professional.
3. Know the modifications required in case of mean stress and notches
4. To understand various cycle counting methods used in industries and in commercial software.
5. Familiarize with the fatigue of spot welds.

Module-1
Fatigue Damage Theories: Fatigue damage mechanism, Cumulative damage models,Linear damage models,Double linear damage rule by Manson and Halford.
Module-2
Stress-Based Fatigue Analysis and Design: Introduction,The stress-life (S-N) and fatigue limit testing, Estimated SN curve of a component based on ultimate tensile strength, Notch effect, Mean stress effect,Combined proportional loads.
Module-3
Strain-Based Fatigue Analysis and Design: Introduction, Experimental test program, Analysis of monotonic and cyclic stress–strain behaviour of materials,Mean stress correction methods,Estimation of cyclic and fatigue properties,Notch analysis.
Module-4
Cycle Counting Techniques: One-parameter cycle counting methods,Two-parameter cycle counting methods,Four-Point Cycle Counting Method,Reconstruction of a load-time history.
Module-5
Fatigue of Spot Welds: Introduction, WeldSpecimen Testing for Fatigue life calculation.

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:

7. Two Unit Tests each of **25 Marks**
8. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

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

Suggested Learning Resources:

Books

1. Yung-Li Lee, Jwo Pan, Richard Hathaway, Mark Barkey." Fatigue Testing and Analysis : Theory and Practice", Elsevier, 2005.
2. Julie A. Bannantine, Jess J. Comer, James L. Handrock, "Fundamentals of Metal Fatigue Analysis", Prentice Hall, 1990.
3. Ralph I. Stephens, Ali Fatemi, Robert R. Stephens, Henry O. Fuchs, "Metal Fatigue in Engineering", John Wiley & Sons, 2000.
4. Anderson T L, "Fracture Mechanics: Fundamentals and Applications", 4th Edition, CRC Press, 2017.
5. ASTM Standard E399, "Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness KIc of Metallic Materials," ASTM International.
6. MSC Fatigue 2021.4 (Theory Guide): (https://www.mscsoftware.com)

Web links and Video Lectures (e-Resources):

1. Practical Fatigue Theory (Online) (https://www.ncode.com/services/training-courses/practical-fatiguetheory-ncode-training-online)
2. Constant Amplitude Stress-Life Analysis ,(https://www.efatigue.com/constantamplitude/stresslife/#a)
3. Fatigue & Fracture Mechanics in FEA (https://www.nafems.org/training/e-learning/fatigue-fracture-fea/)
4. What is Fatigue Analysis? | MSC Nastran (https://simulatemore.mscsoftware.com/what-is-fatigueanalysis-msc-nastran/)

Skill Development Activities Suggested

1. Run a MSC NASTRAN Fatigue Analysis
2. Try A sample Problem of Spot Welding in MSC Fatigue
3. Explore various Fatigue and Fracture software.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Correctly predict Fatigue life of metal components using Stress and Strain life Methods.	3
CO2	Analyse the situation to apply appropriate fatigue failure method	3
CO3	Identify and describe the basic fatigue mechanisms.	2
CO4	Demonstrate the application of the methods for fatigue life of spot Weld	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	**1**				**1**
CO2	**3**				**1**
CO3	**3**				**1**
CO4	**3**				**3**

Semester- 2

Stress Analysis			
Course Code	MMEA214C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand concept of stress and strain analysis at a point.
- To understand the various facets of elasticity problems
- To study methods of analysis for beams stresses and strains
- To study different techniques of stress analysis under energy methods

Module-1

Analysis of Stress : Introduction , Analysis and Design, Conditions of Equilibrium , Definition and Components of Stress, Internal Force Resultant and Stress Relations, Stresses on Inclined Sections, Variation of Stress within a Body, Plane-Stress Transformation, Principal Stresses and Maximum In-Plane Shear Stress, Mohr's Circle for Two-Dimensional Stress, Three-Dimensional Stress Transformation, Principal Stresses in Three Dimensions, Normal and Shear Stresses on an Oblique Plane, Mohr's Circles in Three Dimensions, Boundary Conditions in Terms of Surface Forces.

Module-2

Strain and Material Properties: Introduction, Deformation, Strain Defined, Equations of Compatibility, State of Strain at a Point, Engineering Materials, General Properties of Some Common Materials, Stress- Strain Diagrams, Elastic versus Plastic Behavior, Hooke's Law and Poisson's Ratio, Generalized Hooke's Law, Orthotropic Materials, Measurement of Strain: Strain Gage, Strain Energy, Strain Energy in Common Structural Members, Components of Strain Energy, Saint-Venant's Principle.

Module-3

Problems in Elasticity: Introduction, Fundamental Principles of Analysis, Plane Strain Problems, Plane Stress Problems, Comparison of Two-Dimensional Isotropic Problems, Airy's Stress Function, Solution of Elasticity Problems, Thermal Stresses.

Module-4

Failure Criteria: Static Loading: Failure by Yielding, Failure by Fracture, Yield and Fracture Criteria, Maximum Shearing Stress Theory, Maximum Distortion Energy Theory, Octahedral Shearing Stress Theory, Comparison of the Yielding Theories, Maximum Principal Stress Theory, Mohr's Theory, Coulomb–Mohr Theory.

Module-5

Bending of Beams: Exact Solutions - Pure Bending of Beams of Symmetrical Cross Section, Pure Bending of Beams of Asymmetrical Cross Section, Bending of a Cantilever of Narrow Section, Bending of a Simply Supported Narrow Beam, Approximate Solutions – Elementary Theory of Bending, Normal and Shear Stresses, Effect of Transverse Normal Stress, Composite Beams, Shear Center.

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:

9. Two Unit Tests each of **25 Marks**
10. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

21. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Books

1. Ansel C. Ugural, Saul K. Fenster, "Advanced Mechanics of Materials and Applied Elasticity", 6th Edition, Pearson Education, 2020
2. S.P. Timoshenko and J.N. Goodier, "Theory of Elasticity," McGraw-Hill, Third Ed., New York, (1970)
3. Arthur P. Boresi, Richard J. Schmidt,"Advanced Mechanics of Materials", 6th Edition. Wiley, 2002

Web links and Video Lectures (e-Resources):

1. Strength of Materials :https://nptel.ac.in/courses/112107146
2. Advanced Strength of Materials, https://nptel.ac.in/courses/112101095
3. Mechanics of Solids :https://www.youtube.com/watch?v=whB7IX3NQpg&list=PL4C9BB8DDD5D888A6

Skill Development Activities Suggested

1. Write a small application to display Mohr's circle for a given stress condition and to find principal stresses
2. Develop an application which can solve the displacement and stress of a beam for any end condition

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Determine stress distribution along a component under different loading conditions.	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	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

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

Semester- 2

Mechanical Behaviour of Materials			
Course Code	MMEA214D	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To familiarize the concept of deformation mechanisms in single crystal and polycrystalline materials.
- To study strengthening mechanisms and mechanics of fracture in ductile and brittle materials
- To study the fatigue and creep properties of materials under various conditions
- To familiarize the various characterization techniques used to probe mechanical properties.

Module-1

Plastic Deformation: Concepts of crystals, Plastic deformation by slip and twinning, Slip systems in FCC, BCC and HCP lattices, Critical resolved shear stress for slip, Theoretical shear strength of solids, Stacking faults and deformation bands.

Module-2

Dislocation Theory : Observation of dislocations, Climb and cross slip, Dislocations in FCC and HCP lattice, Partial dislocations, Stress fields and energies of dislocations, Forces between dislocations, Interaction of dislocations, Dislocation sources and their multiplications.

Module-3

Strengthening Mechanisms: Strengthening from grain boundaries, Grain size measurements, Yield point phenomenon, Strain aging, Solid solution strengthening, Strengthening from fine particles, Fiber strengthening, Cold working and strain hardening, Annealing of cold worked metal.

Module-4

Creep and Stress Rupture: Creep curve, Stress rupture test, Mechanism of creep deformation, Activation energy for steady state creep, Super-plasticity, Fracture at elevated temperature, Creep resistant alloys, Creep under combined stresses.

Module-5

The Tension Test: Stress-strain curves, Instability in tension, Ductility measurement, Effect of strain rate, temperature and testing machine on flow properties, Stress relaxation testing, Notch tensile test, Anisotropy of tensile properties.

The Hardness Test: Brinnel, Rockwell and Vickers hardness, flow of metal under the indenter, relationship between hardness and flow curve, micro hardness testing, Hardness at elevated temperatures.

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:

11. Two Unit Tests each of **25 Marks**
12. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

26. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Books

1. Dieter M. George, Mechanical Metallurgy, McGraw- Hill Inc., 2001.
2. Richard W Hertzberg Deformation and fracture mechanics, John Wiley & Sons
3. Reed Hill and Robert E, Physical Metallurgy Principles, East West Press
4. Hyden W. M. Structure and properties of Materials, Vol. 3, McGraw Hill

Web links and Video Lectures (e-Resources):

- Mechanical Behavior of Materials https://onlinecourses.nptel.ac.in/noc21_mm27/preview
- Mechanical Behaviour of Materials https://onlinecourses.nptel.ac.in/noc22_mm04/preview

Skill Development Activities Suggested

- Use a strain gage setup to estimate the strains at a surface point of a plate subjected to tensile loading
- Identify and list the values of SN curves for various alloys of Steel and Aluminium

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the effect of dislocations and their interaction on the material strength	2
CO2	Apply the concept of fracture toughness to material failure	2
CO3	Carry out the Tensile test for a steel specimen	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	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	5

Mapping of COS and POs

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

PROFESSIONAL ELECTIVE 4

Semester- 2

Mechatronics System Design			
Course Code	MMEA215A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To educate the student regarding integration of mechanical electronics electrical and computer systems in the design of CNC machine tools
- To provide students with an understanding of the mechatronic design process actuators, sensors transducers signal conditioning, MEMS and Microsystems
- To introduce Advanced Application in mechatronic

Module-1
Definition and Introduction to Mechatronic System, Modelling &Simulation of Physical systems, Overview of Mechatronic Products and their functioning, measurement systems, Control Systems, simple Controllers, Study of Sensors and Transducers, Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.
Module-2
Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors System Models, Mathematical models, mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.
Module-3
Signal Conditioning: Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals Multiplexers, Data Acquisition, Introduction to digital system processing, pulse modulation. MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging.
Module-4
System model, Engineering systems, rotational-translational system, electromechanical systems, Hydraulic-mechanical systems. Dynamics responses of systems, modelling dynamic systems, first order system, second order system, performance measures for second – order systems. Systems transfer functions, the transfer function, first order systems second order systems, system in series.
Module-5
Microprocessors, control, microprocessor systems, microcontrollers, applications, Assembly language, languages, instruction sets, assembly language programs, C languages-Why C, Program structure, branched and loops, arrays, pointers program developments.

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:

13. Two Unit Tests each of **25 Marks**
14. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

31. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Books

1. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999
2. HSU "MEMS and Microsystems design and manufacture"- Tata McGraw-Hill Education, 2002
3. Kamm, "Understanding Electro-Mechanical Engineering an Introduction to Mechatronics"- IEEE Press, 1 edition ,1996
4. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010
5. Mahalik "Mechatronics"- Tata McGraw-Hill Education, 2003

Web links and Video Lectures (e-Resources):

1. Design of Mechatronic Systems (https://onlinecourses.nptel.ac.in/noc21_me129/preview)
2. Virtual Laboratory, Ministry of Education, Government of India. (https://www.vlab.co.in/broad-areamechanical-engineering)

Skill Development Activities Suggested

- Try exploring various laboratories provided in Virtual Laboratory, Ministry of Education, Government of India.
- Write few assembly programs targeted at any of the Intel microprocessors.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe mechatronic systems and overview of control systems & actuators	2
CO2	Identify and describe the different types of actuators used in mechatronic systems	2
CO3	Differentiate between various sensors, transducers and actuators and their application	4
CO4	Identify and describe the different types of speed and position-feedback devices	2
CO5	Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers	4
CO6	Discuss the importance of feedback in controlling physical systems with the use of examples	2
CO7	Identify and describe the types of controllers used in mechatronic systems	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.	5
5	Students should be able to conduct analytical and experimental investigations on Industrial and societal problems to provide sustainable solutions.	6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**3**	**1**	**3**	**2**
CO2	**3**	**3**	**1**	**3**	**2**
CO3	**3**	**3**	**1**	**2**	**2**
CO4	**3**	**3**	**1**	**3**	**2**
CO5	**3**	**3**	**1**	**3**	**1**
CO6	**3**	**3**	**1**	**2**	**2**
CO7	**2**	**3**	**1**	**2**	**2**

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

Semester- 2

Computer Aided Geometric Design			
Course Code	MMEA215B	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To discuss the Mathematical techniques for the definition and manipulation of curves and surfaces.
- To explore the various curves used in CAD.

Module-1

Transformations of the Plane: Introduction, Translations, Scaling about the Origin, Reflections, Rotation about the Origin, Shears, Concatenation of Transformations, Applications.

Module-2

Homogeneous Coordinates and Transformations of the Plane: Introduction, Points at Infinity, Visualization of the Projective Plane, Transformations in Homogeneous Coordinates, Concatenation of Transformations , Applications, Point and Line Geometry in Homogeneous Coordinates.

Module-3

Homogeneous Coordinates and Transformations of Space: Homogeneous Coordinates, Transformations of Space, Applications, Geometric Methods for Lines and Planes in Space, Quaternions**.**

Module-4

Projections and the Viewing Pipeline: Introduction, Projections of the Plane , Projections of Threedimensional Space, The View plane Coordinate Mapping, The Viewing Pipeline , Classification of Projections.

Module-5

Curves: Introduction, Curve Rendering, Parametric Curves, Arc length and Reparametrization, **Application:** Numerical Controlled Machining and Offsets, Conics, Conics in Space, Applications of Conics.

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:

15. Two Unit Tests each of **25 Marks**
16. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

36. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Books

1. Duncan Marsh, Applied Geometry for Computer Graphics and CAD, 2ndEdition, Springer-Verlag London Limited 2005
2. Gerald Farin, Curves and Surfaces for Computer Aided Geometric Design, A Practical Guide. Morgan Kaufmann, 5th ed., ISBN 1-55860-737-4, 2002.
3. Nicholas M. Patrikalakis and Takashi Maekawa, Shape Interrogation for Computer-Aided Design and Manufacturing, Springer 2001.

Web links and Video Lectures (e-Resources):

1. https://class236716.cs.technion.ac.il/lectures/
2. https://cs.ucdavis.edu/schedules-classes/ecs-278-computer-aided-geometric-design

Skill Development Activities Suggested

1. Writing MATLAB code to represent curves and surfaces
2. Codes to simulate geometric transformations
3. Code and operate the Bezier and other similar curves

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Perform the basic transformations of geometrical objects	3
CO2	Operate in the homogeneous coordinate system	3
CO3	Define, Code and Use various curves	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

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1										
CO2										
CO3										
CO4										
CO5										

Semester- 2

Industry 4.0			
Course Code	MMEA215C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To impart basic idea in Industry 4.0.
- To provide students with good depth of knowledge of designing Industrial 4.0 Systems for various application
- Learn the concepts of Robotics and Augmented Reality

Module-1
Introduction to Industry 4.0: Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0
Module-2
A Conceptual Framework for Industry 4.0: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.
Module-3
Technology Roadmap for Industry 4.0: Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.
Module-4
Advances in Robotics in the Era of Industry 4.0: Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.
Module-5
Obstacles and Framework Conditions for Industry 4.0 : Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure.

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:

17. Two Unit Tests each of **25 Marks**
18. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

41. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Books

1. Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing the Digital Transformation".
2. Bartodziej, Christoph Jan,"The Concept Industry 4.0".
3. Klaus Schwab,"The Fourth Industrial Revolution".
4. Christian Schröder,"The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit
- Case study

Course outcome (Course Skill [Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe Industry 4.0 and scope for Indian Industry	2
CO2	Demonstrate conceptual framework and road map of Industry 4.0	3
CO3	Describe Robotic technology and Augmented reality for Industry 4.0	3
CO4	Demonstrate obstacle and framework conditions for Industry 4.0	4

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.	3

Mapping of COS and POs

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

Semester- 2

Design for Manufacturing and Assembly			
Course Code	MMEA215D	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understanding the basic rules for design for manufacturing and material selection.
- Applying the guidelines for ease of design, manufacturing and assembly.
- Analyze factors for selection of material and process, relationship to manufacturing processes
- Apply the concepts of design for manufacturing and assembly for product manufacturing.
- Compare various manufacturing processes and assembly techniques required for product
- development to optimise the process.

Module-1

Material and process selection – Introduction, Advantages of applying DFMA, General requirements of early materials and process selection, Selection of Manufacturing processes, Selection of materials. Engineering Design features. – Dimensioning, Tolerances, General Tolerance, Geometric Tolerances,

Module-2

Assembly limits, Datum features.
Component design – Machining Considerations – Drills, Milling cutters, Drilling, Keyways, Dowels, Screws, Reduction in machining areas, Simplification by separation and amalgamation, work piece holding, surface grinding, Examples.

Module-3

Component design – Casting Considerations – Pattern, Mould, parting line, cast holes, machined holes, identifying parting line, special sand cores, designing to obviate sand cores. Examples

Module-4

Design for Injection molding and Sheet metal working – Injection molding materials, Molding cycle, Systems, molds, machine size, cycle time, Cost estimation, Insert molding, Design guidelines, Introduction to sheet metalworking.

Module-5

Selective Assembly: Interchangeable part manufacture and selective assembly, deciding the number of groups Group tolerance of Mating parts equal, Model total and group tolerances of shaft equal. Control of axial play- Introducing secondary machining operations, laminated shims, examples.

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:

19. Two Unit Tests each of **25 Marks**
20. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

46. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Books

- Product Design for Manufacture and Assembly – Geoffrey Boothroyd - Peter Dewhurst - Winston Knight
- Designing for Manufacturing – Harry Peck - Pitman Publications – 1983
- Dimensioning and Tolerancing for Quantity Production – Merhyle F Spotts –Inc. Englewood Cliffs - New Jersey - Prentice Hall, 5thedition.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the principles of manufacturability and design for manufacture	2
CO2	Design casting for economic production.	4
CO3	Understand the concept of easy assembly, based on rules of DFMA to reduce the time of assembly.	2
CO4	Redesign the parts for easy manufacturing based on rules of DFMA to reduce the time of manufacturing and enhance cost effectiveness.	4
CO5	Design guidelines and background for powder metallurgy parts and reviewing of formed parts.	5

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.	2
3	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**	**2**			**1**
CO2	**1**	**2**			**1**
CO3	**3**	**2**			**1**
CO4	**3**	**2**			**1**
CO5	**3**	**2**			**1**

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

Semester- 2

Advanced Mechanics of Solids			
Course Code	MMEA206	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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

Module-1

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.

Module-2

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.

Module-3

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.

Module-4

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.

Module-5

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.

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:

21. Two Unit Tests each of **25 Marks**
22. Two assignments each of **25 Marks**or **oneSkill Development Activity of 50 marks** to attain the COs and POs

The sum of two 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:

51. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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	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**

Finite Element Methods Laboratory			
Course Code	MMEAL207	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	2	Exam Hours	03

Course objectives:

- To familiarize the students with a commercial / open source FEM Software
- To make students practice problems in Linear Elastic, Dynamic and Non-Linear Finite Element Analysis using any commercial software such as NASTRAN/ABAQUS etc.

Sl.NO	Experiments
	Linear Static Analysis:
1	Linear Static Analyses of a Simply-Supported Truss, Simply-Supported Stiffened Plate and a Solid Lug.
2	Rigid Element Analysis with RBAR: Create a tube model with a 'rigid' end and apply a torque load for linear static analysis (Rigid Element Analysis with RBAR or equivalent)
	Dynamic Analysis:
3	Modal Analysis of a Flat Plate: find first five natural frequencies and mode shapes). Repeat the analysis with static reduction.
4	Direct Transient Response Analysis: Using the direct method, define time-varying excitation and compute nodal displacement for desired time domain. Repeat the analysis using the modal method.
5	Direct Frequency Response Analysis:Using the direct method define frequency-varying excitation and compute nodal displacement for desired frequency domain. Repeat the analysis with modal method
6	Random Analysis of flat plat: Determining the displacement response spectrum from random pressure and force loads with cross spectrum correlation.
	Non-Linear Analysis:
7	Spring Element with Nonlinear Analysis Parameters (Multi-Step Analysis): Demonstrate the effects of geometric nonlinear analysis with incremental loads through multiple sub cases and interpret the results with different output options.
8	Geometric Nonlinear Analysis of a Cantilever Beam: Perform nonlinear analysis on a cantilever beam under four increasing loads, create an accurate deformation plot of the model and a plot of the load factor vs. displacement.
	Demonstration Experiments (For CIE) if any
9	A plate with a part-through crack: elastic line spring modelling:A large plate with a symmetric, centrally located, semi-elliptic, part-through crack is subjected to edge tension and bending. Estimate the Mode I stress intensity factor, KI as a function of position along the crack front.
10	Z-section cantilever under torsional loading. A Z section cantilever (1 m, 2m,1m) with thickness 0.1 m is subjected to a torque of 1.2 MN-m applied at 10. The torque is applied by two uniformly distributed edge shears of 0.6 MN at each flange when shell elements are used. All displacements are zero along the edge at 0. The material properties are Young's modulus = 210 GPa, Poisson's ratio = 0.3, density = 7800 kg/m^3. In the explicit dynamic analysis the loading rate is applied such that a quasi-static solution is obtained. Find the axial stress, at mid-surface, and stress at point A (2.5 m from fixed edge).
11	Plane stress elements—elliptic membrane (NAFEMS Benchmark Problem): A thin steel plate of thickness 0.1 mm defined between two ellipses (outer: $(x/3.25^2) + (y/2.75) = 1$ and

	inner: $(x/2^2) + y/1^2 = 1$) is subjected to uniform outer pressure of 10 MPa. Find Tangential edge stresses (σyy).
12	Laminated strip under three-point bending: A Laminate of size(50 mm x10 mm x1 mm), Lamina arrangement of0/90/0/90/0/90/0 (all lamina with thickness 0.1mm and the middle lamina with thickness 0.4mm) have the material properties = 100 GPa, = 5 GPa, = 5 GPa, = 0.4, = 0.3, = 0.3, = 3 GPa, = 2 GPa, = 2 GPa . The plate is simply supported by two supports at 10 mm from ends. A Line load of10 N/mm is applied at the centre (x = 25, z = 1). Find the stresses, σ11 and σ13 and Uz.

Course outcomes (Course Skill Set):

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

- Run a Linear Static, Dynamic and Non- Linear Analysis for simple components
- Find the stress and displacement in a commercial software
- Demonstrate the validity of FE results against a set standard.

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 an 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 down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In 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 test marksis scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test 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:

- https://www.scc.kit.edu/scc/sw/msc/Webwork/NasBooks.html
- Abaqus Examples problem guide: http://wufengyun.com:888/books/exa/default.htm?startat=pdx01pdd01.html
- National Agency for Finite Element Methods and Standards (U.K.): Test LE1 from NAFEMS publication TNSB, Rev. 3, "The Standard NAFEMS Benchmarks," October 1990.
- http://wufengyun.com:888/books/bmk/default.htm?startat=book01.html#bmk
- National Agency for Finite Element Methods and Standards (U.K.): Test R0031/1 from NAFEMS publication R0031, "Composites Benchmarks," February 1995. (http://wufengyun.com:888/books/bmk/default.htm?startat=book01.html#bmk)
- National Agency for Finite Element Methods and Standards (U.K.): Test LE5 from NAFEMS publication TNSB, Rev. 3, "The Standard NAFEMS Benchmarks," October 1990. (http://wufengyun.com:888/books/bmk/default.htm?startat=book01.html#bmk)

ABILITY ENHANCEMNET COURSE

Basics of Matlab		Semester	II
Course Code	MMEA258A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12-14 Sessions	Total SEE+CIE	100
Credits	01	Exam Hours	03
Examination type (SEE)	**Practical**		

Course objectives:

- To know about fundamentals of MATLAB tool.
- To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
- To understand the concept and importance of Fourier transforms.
- To gain knowledge about MATLAB Simulink & solve engineering problems

Sl. NO	Experiments
1	Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples.
2	
3	Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.
4	
5	Numerical Integration and Differentiation: Trapezoidal method, Simpson method.
6	
7	Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss Siedal and Newton Raphson method.
8	
	Demonstration Experiments (For CIE)
9	Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order RungaKutta method, MATLAB ode45 algorithm in single variable and multivariable.
10	Transforms: Discrete Fourier Transforms
11	Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits
12	MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems

Course outcomes (Course Skill Set):

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

- Implement loops, branching, control instruction and functions in MATLAB programming environment.
- Programming for curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve engineering problems.
- Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
- Simulate MATLAB Simulink examples.

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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 marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

Text Books:

1. Agam Kumar Tyagi, "MATLAB and Simulink for Engineers", OXFORD Higher Education.
2. Dr. Shailendra Jain, "Modelling & Simulation using MATLAB – Simulink", Wiley – India.

Reference Books:

1. Won Y.Tang, Wemun Cao, TaeSang Ching and John Morris, “Applied Numerical Methods Using MATLAB”, A John Wiley & Sons.
2. Steven T. Karris, “Introduction to Simulink with Engineering Applications”, Orchard Publications.

Fundamentals On Spreadsheet		Semester	
Course Code	MMEA258B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	10-12 Sessions	Total SEE+CIE	100
Credits	01	Exam Hours	2
Examination type (SEE)	**Practical**		

Course objectives:

- To create different plots and charts To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Sl. No.	Experiments
1	**Charting:** Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	**Functions:** Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3	**Conditional Functions:** Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	**Regression Analysis:** Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.
5	**Iterative Solutions Using Excel:** Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.
6	**Matrix Operations Using Excel:** Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
7	**VBA User-Defined Functions (UDF):** The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure
8	**VBA Subroutines or Macros:** Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.
	Demonstration Experiments (For CIE)
9	Aerospace equations: Many of the aerospace equations, such as lift and drag coefficients, can be calculated using custom formulas in Excel

10	Wind tunnel correction functions: To correct wind tunnel data based on atmospheric conditions.("ISBLANK" and "IF" functions can be used)
11	Flight trajectory functions: To look up flight path parameters based on any given conditions.("Vlookup" and "Match" functions can be used)
12	Launch vehicle functions: To look up rocket performance parameters based on any given conditions.("INDEX" and "MATCH" functions can be used)

Course outcomes (Course Skill Set):

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

- To create different plots and charts To compute different functions, conditional functions and make regression analysis
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different 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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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 marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by**

the university.

- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- McFedries PaulMicrosoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

Fundamental of Virtual Reality ARP Development		Semester	II
Course Code	**MMEA258C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- Describe how VR systems work and list the applications of VR.
- Understand the design and implementation of the hardware that enables VR systems to be built.
- Understand the system of human vision and its implication on perception and rendering.
- Explain the concepts of motion and tracking in VR systems.
- Describe the importance of interaction and audio in VR systems

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Virtual Reality: Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual WorldInput & output Visual, Aural & Haptic Displays, Applications of Virtual Reality.

Module-2

Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR

Module-3

The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, AxisAngle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.

Module-4

Visual Perception & Rendering: Visual Perception Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.

Module-5

Motion & Tracking: Motion in Real and Virtual Worlds Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies

Course outcome (Course Skill Set)

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

CO1: Describe how VR systems work and list the applications of VR.

CO2: Understand the design and implementation of the hardware that enables VR systems to be built.

CO3: Understand the system of human vision and its implication on perception and rendering.

CO4: Explain the concepts of motion and tracking in VR systems.

CO5: Describe the importance of interaction and audio in VR systems.

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

Text Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016

2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002

3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.

2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.

3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.

4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Web links and Video Lectures (e-Resources):

- http://lavalle.pl/vr/book.html
- https://nptel.ac.in/courses/106/106/106106138/
  https://www.coursera.org/learn/introductionvirtualreality.

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

- Course Seminars

Introduction Augmented Reality		Semester	II
Course Code	MMEA258D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- Describe how AR systems work and list the applications of AR.
- Understand and analyse the hardware requirement of AR.
- Use computer vision concepts for AR and describe AR techniques
- Analyse and understand the working of various state of the art AR devices
- Acquire knowledge of mixed reality

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Augmented Reality (A.R): Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality and Other TechnologiesMedia, Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality

Augmented Reality Concepts: Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.

Module-2

Augmented Reality Hardware:

Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model.

Processors – Role of Processors, Processor System Architecture, Processor Specifications.

Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.

Module-3

Computer Vision for Augmented Reality & A.R. Software: Computer Vision for Augmented Reality Marker Tracking, Multiple Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking

Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.

Module-4

AR Techniques - Marker based & Marker less tracking: Marker based approach Introduction to marker based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication.

Module-5

AR Devices & Components: AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene

AR Devices – Optical See through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see through systems

Course outcome (Course Skill Set)

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

CO1 : Describe how AR systems work and list the applications of AR.

CO2 : Understand and analyse the hardware requirement of AR.

CO3 : Apply computer vision concepts for AR and describe AR techniques

CO4 : Analyse and understand the working of various state of the art AR devices

CO5 : Explain the knowledge acquired on mixed reality

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

Text Books:

1. Allan Fowler – AR Game Development‖, 1st Edition, A Press Publications, 2018, ISBN 978-1484236178

2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN- 10: 9332578494

Reference Books:

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 978149162381

2. Sanni Siltanen Theory and applications of markerbased augmented reality. Julkaisija – - Utgivare Publisher, 2012. ISBN 978-951-38-7449-0

Web links and Video Lectures (e-Resources):

- https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf
- https://docs.microsoft.com/enus/windows/mixedreality/
- https://docs.microsoft.com/en-us/archive/msdnmagazine/2016/november/hololensintroductiontotheholoLens

MOOC Courses:

- https://www.coursera.org/learn/ar
- https://www.udemy.com/share/101XPi/

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

- Course seminar
- Term project

For the students who are willing to take up a two-semester duration Industry/Research Internship Leading to Project work /start-up

IIISEMESTER (A)

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini-Project/ Internship	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PEC/MDC	MMEA311x	(Online Courses) 12 weeks duration							100	3
2		MMEA312x	(Online Courses)12 weeks duration							100	3
		MMEA313x	(Online Courses)12 weeks duration							100	3
3	INT	**MINT384**	Research Internship /Industry-Internship leading to project work/ Startup	Two-semester duration, SEE in the IV semester which leads to project work /start-up			03	100	---	100	3
TOTAL										**400**	**12**

IV SEMESTER (A)

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/Field work	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P					
1	INT	MINT481	Research Internship / Industry Internship Leading to Project Work/Start-up	Two Semester Duration		03	100	100	200	12
2	PROJ	MPRJ482	Project			03	100	100	200	16
TOTAL						**06**	**200**	**200**	**400**	**28**

INT: Industry/ Research Internship leading to the project work /startup**PRJ**: Project work outcome of Internship (Project Phase-II is Viva voce SEE)

Taking up a two-semester Industry/Research Internship that leads to project work or a start-up can be a highly rewarding experience for students. It allows them to apply theoretical knowledge in practical settings, gain valuable industry or research experience, and potentially develop innovative solutions or business ideas. Here are some key steps and considerations for students pursuing such an internship:

Industry Internship: The main objective of the industry internship is to ensure that the intern is exposed to a real-world environment and gain practical experience. Often, it may be a practical exposure to the theory that has been learned during the academic period. The industry internship helps students understand of analytical concepts and tools, hone their skills in real-life situations, and build confidence in applying the skills learned.

Research Internship: A research internship is an opportunity for students or early career professionals to gain hands-on experience in conducting research under the guidance of a mentor or within a research team. These internships can take place in academic institutions, research organizations, government agencies, or private companies

Research /Industry Internship: In the third-semester Students have to be in touch with a guide/mentor/coordinator and regularly submit the report referred to the progress internship. Based on the progress report the Guide/Mentor/coordinator has to enter the CIE marks at the end of the 3rd semester. At the beginning of the 4th semester, students have to define the project topic out of the learning due to the Internship, upon completion of the project work he/she has to attend the SEE at the parent Institute.

Internship Leading to Start-up: An internship that leads to a startup is an exciting pathway, blending real-world experience with entrepreneurial ambition. Here's a comprehensive guide to transitioning an internship experience into launching your startup: 1) Maximize your internship experience, 2) Identifying Viable Business Ideas, 3) Research and Validation 4) Building a Business Plan 5) Networking and Mentorship 6) Securing Funding 7) Establishing Startup 8) Launching and Marketing. By following these steps, you can effectively transition from an internship to launching a successful startup. This journey requires dedication, resilience, and a willingness to learn and adapt.

MMEA311 to 313:MOOC courses of 12 weeks duration are the courses suggested by the Board of Studies of the University and will be displayed on www.online.vtu.ac.in. The online courses selected should not be the same as those studied in the first and second semesters of the program. The student will not be eligible to get their degree if they unintentionally select online courses that match previously finished courses. These courses are not considered for the vertical progression; however, qualifying for these courses and earning the credits is a must for the award of the degree. It is permitted to complete these online MOOC courses either in 3rd semester or in 4th semester.

For the students who are willing to take an Industry Internship for one-semester duration and independent project work next semester

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2024
M.Tech., Title of the Programme (XXX) (Font 12 Capital, Calibri)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

IIISEMESTER (B)

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	MDC/PEC	MMEA311	(Online Course) (12 weeks courses)							100	3
		MMEA312	(Online Course) (12 weeks courses)							100	3
2		MMEA313	(Online Courses) (12-week course)							100	3
3	INT	24INT384	Industry Internship	One semester Duration			03	100	100	200	11
TOTAL				**06**	**00**	**00**				**500**	**20**

IV SEMESTER (B)

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	MPRJ481	Project work	--	08	03	100	100	200	20
				04	**08**	**03**	**100**	**100**	**200**	**20**

Industry Internship: The main objective of the industry internship is to ensure that the intern is exposed practical experience. Often, it may be a practical exposure to the theory that has been learned duri internship helps students understand of analytical concepts and tools, hone their skills in real-life situatio skills learned. The students who take up a one-semester Internship in the Industry have to appear SEE at as per the examination calendar.

Project Work: Students in consultation with the guide shall carry out literature survey/ visit industries to Subsequently, the students shall collect the material required for the selected project, prepare a synopsis, ar the project work. Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through Power Point slides.
- Answer the queries and be involved in debate/discussion.
- Submit two copies of the typed report with a list of references.
- The participants shall take part in discussions to foster a friendly and stimulating environment in wh high standards and become self-confident

CIE marks for the project report (20 marks), seminar (20 marks) and question and answer (10 marks) sh report and presentation skill, participation in the question and answer session by the student) by the comm Principal. The committee shall consist of internal guide and a faculty from the department with the senior m **Semester End Examination** SEE marks for the project report (30 marks), seminar (10 marks) and questio awarded (based on the quality of the report and presentation skill, participation in the question and answe the University.

MMEA311 to 313:MOOC courses of 12 weeks duration are the courses suggested by the Board of Studies c www.online.vtu.ac.in. The online courses selected should not be the same as those studied in the first an student will not be eligible to get their degree if they unintentionally select online courses that match previ not considered for the vertical progression; however, qualifying for these courses and earning the credits is permitted to complete these online MOOC courses either in 3rd semester or in 4th semester.

For the students who are willing to take a research-leading paper publication in Q1/Q2/Q3 Journals and to a PhD Registration											
IIISEMESTER (C)											
Sl. No	**Course**	**Course Code**	**Course Title**	**Teaching Hours /Week**			**Examination**				**Credits**
				Theory	**Practical/ Mini–Project/ Internship**	**Tutorial/ Skill Development Activities**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
				L	P	SDA					
1	PCC/IPCC/ MDC/PEC	MMEA311	(Online Course) (12 weeks courses)							100	3
		MMEA312	(Online Course) (12 weeks courses)							100	3
2		MMEA313	(Online Courses) (12-week course)							100	3
		MMEA314	(Online Courses) (12-week course)							100	3
3	PROJ	MPRJ385	Project Phase-I	One semester Duration			03	100	---	100	6
TOTAL				**06**	**00**	**00**	**09**			**500**	**18**

IV SEMESTER (C)										
Sl. No	**Course**	**Course Code**	**Course Title**	**Teaching Hours /Week**		**Examination**				**Credits**
				Theory	**Practical/ Field work**	**Duration in hours**	**CIE Marks**	**SEE Marks Viva voce**	**Total Marks**	
				L	P					
1	Project	MPRJ481	Project work	--	08	03	100	100	200	22
				04	**08**	**03**	**100**	**100**	**200**	**22**

The research section of the university has to announce the number of seats for M.Tech. students who are seeking PhD (research study) admission through a project leading to the publication of the paper in Q1/Q2/Q3 journals. Only full-time research work will be permitted in the university department or approved research centers of the affiliated colleges of the university (guidelines need to be set up). Based on seat availability, the students are permitted to register for project work leading to the publication of papers in Q1/Q2/Q3 journals and

admission to research (PhD) in their 3rd semester of the M.Tech., program

Project Phase-1 Project Phase-I, typically the initial phase in any project, is crucial as it lays the foundation for the entire project. This phase involves defining the project's scope, objectives, and initial planning. Here's a structured approach to effectively carry out Project Phase-I:

- **Project Charter:** Outlines the project's purpose, objectives, and stakeholders.
- **Scope Statement:** Defines the project boundaries and deliverables.
- **Requirements Document:** Captures all project requirements.
- **Project Plan:** Details the approach, timeline, and resource allocation.
- **Risk Management Plan:** Identifies and plans for potential risks.
- **Feasibility Study Report:** Assesses technical, economic, and operational feasibility.

Students in consultation with the guide shall carry out literature survey/visit industries to finalize the topic of the Project. Subsequently, the students shall collectthematerialrequiredfortheselectedproject,preparea synopsis,andnarratethemethodologyto carryoutthe projectwork.Eachstudent, under theguidanceofa faculty,is required to

- Presentttheseminarontheselected projectorallyand/orthroughpowerpointslides.
- Answerthe queries and be involved in debate/discussion.
- Submit twocopies ofthetypedreport withalist ofreferences.
- Theparticipantsshalltakepartindiscussionstofostera friendlyandstimulatingenvironmentinwhichthestudentsaremotivatedtoreach the highest and become self-confident.

ContinuousInternalEvaluation(100 Marks).

CIE marks for the project report (60 marks), seminar (20 marks) and question and answer(20marks)shallbeawarded(basedonthequalityofreportandpresentationskill,participation inthequestionandanswersessionbythestudent)bythecommitteeconstitutedforthepurposebytheP rincipal.Thecommitteeshallconsistofan internalguide and afacultyfromthedepartment with theseniormost actingastheChairperson.

ProjectWorkPhase-II: Eachstudentshallbe involvedincarryingouttheprojectwork jointlyinconstantconsultationwithinternalguideandexternalguideandpreparetheprojectreport as perthe norms of the university to avoidplagiarism. Phase II of a project typically involves the detailed execution of the planned activities, continuous monitoring and control of the project's progress, and making necessary adjustments to ensure the project stays on track. Keep detailed records of all project activities, decisions, and changes.Ensure all project documentation is organized and accessible. Conduct a final project review to evaluate overall performance, achievements, and lessons learned. Document best practices and areas for improvement for future projects.

Paper Publication Process: Publishing a research paper based on your project in a Q1/Q2/Q3 journal involves several key steps, from writing the manuscript to navigating the peer review process. Here's a comprehensive guide:

Writing the Manuscript: Choose a clear and concise title that accurately reflects the content. Write an abstract summarizing the research question, methods, results, and conclusions.

Literature Review: Review relevant existing research to establish the foundation of your study.Identify gaps that your research aims to fill.

Methodology: Describe the research design, methods, and procedures in detail.Include information on data collection, analysis, and any tools or software used.

Results: Present the findings of your research clearly and logically.Use tables, figures, and charts to illustrate key results.
Discussion: Interpret the results and explain their implications.Compare your findings with existing research and discuss any discrepancies or new insights.
Conclusion: Summarize the main findings and their significance.Suggest potential future research directions.
References: Cite all sources used in your research following the journal's citation style.
Journal Selection: Choose a journal that aligns with the scope and focus of your research.Consider the journal's impact factor (Q1, Q2, Q3) and audience.
Review Journal Guidelines: Carefully read the journal's submission guidelines and ensure your manuscript adheres to them.
Prepare Your Manuscript: Format your manuscript according to the journal's guidelines.Include all required sections and supplementary materials.
Cover Letter: Write a cover letter to the journal editor highlighting the significance of your research and why it fits the journal.
Submit the Manuscript: Use the journal's online submission system to submit your manuscript.Ensure all required information and documents are included.

Semester End Examination SEE marks for the project report (60 marks), seminar (20marks) and question and answer session (20 marks) shall be awarded (based on the qualityofreportandpresentationskill,participationinthequestionandanswersession)bythe examiners appointedbythe University.