VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Computer Aided Engineering (CAE)
(Effective from the Academic year 2022-23)

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., **Computer Aided Engineering (CAE)**
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC	22CAE11	Mathematical Methods in Engineering	03	00	00	03	50	50	100	3
2	IPCC	22CAE12	CNC System Design	03	02	00	03	50	50	100	4
3	PCC	22CAE13	Machine Learning	03	00	02	03	50	50	100	4
4	PCC	22CAE14	Computer Application In Design	02	00	02	03	50	50	100	3
5	PCC	22CAE15	Advanced Finite Element Methods	02	00	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	00	00	03	50	50	100	3
7	PCCL	22CAEL17	Computer Aided Engineering Laboratory -1	01	02	00	03	50	50	100	2
8	AUD/AEC	22AUD18/ 22AEC18	BOS recommended ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
			TOTAL	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

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

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

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

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

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

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

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Semester- I

MATHEMATICAL METHODS IN ENGINEERING

Course Code	22CAE11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To have an insight into solving roots of equations.
2. Learn to use the roots of polynomial.
3. To learn system of linear algebraic equations.
4. To Learn concepts of linear transformation.

Module-1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton-Raphson method, Secant Method. Multiple roots, Simple fixed point iteration. Roots of polynomial-Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe's Roots Squaring Method.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Numerical Differentiation and Numerical Integration: Newton –Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

System of Linear Algebraic Equations And Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods. Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power
method, Inverse power method.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering. Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets. Model some simple mathematical models of physical Applications and Find the roots of polynomials in Science and Engineering problems
08 Hrs

Teaching-	Chalk and talk method / PowerPoint Presentation

Learning Process	

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

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

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

Semester End Examination:

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

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Suggested Learning Resources:

Books

1. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005
2. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4th Ed,2002.
1. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- http://www.bookstreet.in.
- VTU e-ShikshanaProgram
- VTU EDUSATProgram

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	Model some simple mathematical models of physical Applications	5
CO2	Find the roots of polynomials in Science and Engineering problems.	5
CO3	Differentiate and integrate a function for a given set of tabulated data, for Engineering Applications.	5

Program Outcome of this course

Sl. No.	Description	Pos
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**2**	**1**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**
CO3	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**1**

CNC System Design			
Course Code	**22CAE12**	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:
This course introduces the concepts and capabilities of computer numerical control machine tools. Topics include setup, operation, and basic applications

MODULE-1

Introduction to NC Systems Introduction The History of NC and NC Machine Tools CNC Driving System Components -Driving Motor and Sensor , Linear Movement Guide , Coupling ,CNC Control Loop -Semi-closed Loop ,Closed Loop ,Hybrid Loop, Open Loop. The Components of the CNC system ,MMI Function , NCK Function, PLC Real-time Control System, The Progress Direction of the CNC System. Hardware and Operating Systems, Architecture of Multi-processing Hardware, Operating System Configuration, CNC System Architecture

08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-2

Interpreter-Introduction ,Part Program -Program Structure ,Main Programs and Sub programs ,Main CNC System Functions ,Coordinate Systems ,Interpolation Functions ,Feed Function ,Tools and Tool Functions, Spindle Functions ,Fixed-cycle Function ,Skip Function ,Program Verification ,Advanced Functions G&M-codeInterpreter
Interpolator -Introduction ,Hardware Interpolator -Hardware Interpolation DDA, DDA Interpolation, Software Interpolator -Software Interpolation Methods, Sampled-Data Interpolation ,Fine Interpolation , NURBS Interpolation -NURBS Equation Form , NURBS Geometric Characteristics , NURBS Interpolation Algorithm. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-3

Acceleration and Deceleration -Introduction ,Acc/Dec Control After Interpolation-Acc/Dec Control by Digital Filter ,Acc/Dec Control by Digital Circuit ,Acc/Dec Control Machining Errors ,Block Overlap in ADCAI , Acc/Dec Control Before Interpolation -Speed-profile Generation , Block Overlap Control ,Corner Speed of Two Blocks Connected by an Acute Angle, Corner Speed Considering Speed Difference of Each Axis
PID Control System-Introduction ,The Servo Controller, Servo Control for Positioning ,Position Control ,PID Controller ,PID Gain Tuning ,Feed for ward Control ,Analysis of the Following Error. ,The Following Error of the Feedback Controller ,The Following Error of the Feed forward Controller Comparison of Following Errors 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-4

Open-architectural Soft CNC Systems-Programmable Logic Control - Introduction ,PLC Elements, PLC Programming, Machine Tool PLC Programming , PLC System Functions, Software Model and Communication Model, Programming Model ,User Programming Languages Soft PLC, PLC Configuration Elements ,PLC System Functions, Executor Programming Sequence
08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE 5

Man–Machine Interface -MMI Function, Area for Status Display ,Area for Data Input ,Area for MPG Handling ,Area for Machine Operation ,Structure of the MMI System. CNC Programming. The Sequence of Part Programming, Manual Part Programming ,Automatic Part Programming ,Mazatrol Conversational System ,Turning Conversational System ,Programming Procedure . ,Conversational Programming System Design ,Main Sequence for Design ,Key Design Factors ,Development of the Machining Cycle. ,Turning Fixed Cycle. ,Turning Cycle for Arbitrary Shape ,Corner Machining Cycle .Drilling Sequence 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

Sl.NO	Experiments
1	CNC Programming and Simulation.
2	Setting up of workpiece zero position and machining in Modular Vertical 3 Axis CNC Milling machine.
3	Machining in Semi production Vertical 3 Axis CNC machine (MTab XLMill)
4	Setting up of workpiece zero position and machining in Modular CNC Turning machine.
5	CADEM Programming
6	CNC Turning

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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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 experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

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

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SEE for IPCC

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

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. GROOVER M P, Automation, Production Systems and Computer Integrated Manufacturing -, Prentice Hall India (P) Ltd, 1989.
2. Mikell P. Groover and Emory W. Zimmer, Jr., CAD/CAM Computer Aided Design and Manufacturing, Prentice Hall India (P) Ltd, 1992. (unit 1)
3. M.Koren ―Computer Controls of Manufacturing Systems, McGrawHill, 1983
4. Theory and Design of CNC Systems, Suk-Hwan Suh, SeongKyoon Kang, Dae-Hyuk Chung, Ian Stroud (auth.),Springer Series in Advanced Manufacturing.2008
5. Cad cam cim, 3rd Edition, P. Radhakrishnan (Author), S. Subramanyam, V. RajuNew Age International 3rd edition 2009.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

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

- 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	NC/CNC machines, various elements of CNC machines and its uses.	5
CO2	Constructional features of CNC machine Tools.	5
CO3	Knowledge of CNC programming and its implementation.	4

Program Outcome of this course

Sl. No.	Description	Pos
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**
CO2	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**2**

Machine Learning			
Course Code	22CAE13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

The course is introduced for students to

1. Gain knowledge about basic concepts of Machine Learning
2. Study about different learning algorithms
3. Learn about of evaluation of learning algorithms
4. Learn about Dimensionality reduction

Module-1

Introduction: Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, function approximation.
Inductive Classification: The concept learning task, Concept learning as search through a hypothesis space, General-to-specific ordering of hypotheses, Finding maximally specific hypotheses, Version spaces and the candidate elimination algorithm, Learning conjunctive concepts, The importance of inductive bias
.08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Decision Tree Learning: Representing concepts as decision trees, Recursive induction of decision trees, Picking the best splitting attribute: entropy and information gain, Searching for simple trees and computational complexity, Occam's razor, Overfitting, noisy data, and pruning. Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis dimension.
Rule Learning: Propositional and First-Order, Translating decision trees into rules, Heuristic rule induction using separate and conquer and information gain, First-order Horn-clause induction (Inductive Logic Programming) and Foil, Learning recursive rules, Inverse resolution, Golem, and Progol.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Artificial Neural Networks: Neurons and biological motivation, Linear threshold units. Perceptrons: representational limitation and gradient descent training, Multilayer networks and backpropagation, Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.
Support Vector Machines: Maximum margin linear separators. Quadractic programming solution to finding maximum margin separators. Kernels for learning non-linear functions.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logisitic regression. Bayes nets and Markov nets for representing dependencies.

Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor algorithm. Case-based learning.

08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**

to attain the COs and POs

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Tom M. Mitchell , "Machine learning", McGraw Hill 1997
2. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. Rajjan Shinghal, "Pattern Recognition", Oxford Press, 2006.
4. Ethem Alpaydin, "Introduction to machine learning", PHI learning, 2008.
5. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning", Springer 2001.
6. R.O. Duda, P.E. Hart and D.G. Stork, Pattern Classification, Wiley-Interscience, 2nd Edition, 2000. 3. T.Hastie, R. Tibshirani and J. Friedman, The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer, 2nd Edition, 2009.

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	Identify machine learning techniques suitable for a given problem	5
CO2	Solve the problems using various machine learning techniques	5
CO3	Apply Dimensionality reduction techniques	5
Co4	Design application using machine learning techniques	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**1**	**1**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**3**
CO3	**2**	**2**	**2**	**3**	**3**	**3**	**1**	**2**	**2**	**3**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**3**

Computer Application In Design			
Course Code	22CAE14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To provide the fundamental knowledge of control system engineering and the concept of mathematical modelling of the physical system.
2. The subject gives various classical analysis tools for design and stability of system in time and frequency domain.

Module-1

Points, lines and planar curves: Vector algebra Shapes inside a computer: Review of geometry and trigonometry, Points in a plane: Position vectors, Angles between lines - introducing the third dimension: Scalar products, Finding normal to planes: Vector products 5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Lines in space: Vector equations: Lines in two-dimensional space, in three-dimensional space, Different parametric forms; Lines and common curves: Parametric and Cartesian forms: Linearity and non-linearity, Functions, The parabola, The circle, The ellipse, The circular helix Transformations: Matrix algebra, Tools for transformations: Matrices, Transformations, Matrices, Adding and subtracting matrices, Multiplying matrices; Moving in a plane: Scaling, reflection and rotation: Matrices as geometric operators, Scaling position vectors, Reflecting position vectors in the axes, Rotating position vectors about the origin, Transforming polygons. 5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Combining transformations: Translations, Order in combining transformations, Specific combinations of transformations, Translations, (3x3) Matrices for transformations in a plane Sizing things up: Homogeneous vectors: Simple homogeneous vectors, General homogeneous vectors, Matrix operations using homage vectors Useful manoeuvres: Non-standard rotations and reflections the viewing transformation: Standard and standard, Rotation about an arbitrary point, Reflection in an arbitrary line, The viewing transformation The third dimension: Moving along rays, points at infinity and three-dimensional transformations: Geometrical insights using homogeneous vectors, Completing consideration of (3*3) matrices, Points at infinity, Three dimensional transformations, Some specific (4x4) matrices, Local scaling, Reflections in the coordinate planes, Rotations about the coordinate axes, Translation, Overall scaling, In conclusion. 5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Points of view: Projection and single point perspective: Projection from three dimensions onto a plane, Orthographic projection, The need for perspective, Single point perspective, Perspective projection, Tunnel perspective, To improve realism A greater sense of perspective: Two point and three point perspective: Improving perspective, Translation then single point perspective, Rotation then single point perspective, giving two points perspective, Rotation, translation then single point perspective improved two point perspective, Two rotations, translation then single point perspective, giving three point perspective, The three types of perspective-projection, Vanishing points and trace points Space curves and surfaces: Differentiation, Slopes of lines and planar curves: Gradient functions: Lines and curves, Slope of a straight line from its Cartesian equation, Slope of a curve from its Cartesian equation, Practical rules for differentiation, Slope of a straight line from its vector equations Slopes of

space curves: Tangents and normal, Space curves, the tangent vector to a space curve, Tangents and normal for curves in a plane, Tangents and normal‟s in three dimensions. 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Curve fitting: Interpolation and shape function: Lines and curves from real objects, Linear interpolation, Quadratic interpolation, Uniqueness Planes and surfaces: Bi parametric forms: sweeps and revolutions, Surface formulae and two parameters, Vector equations of planes, The vector equation of a plane, given two vectors in the plans, The vector equation of a plane, given two unit vectors in the plane, The vector equation of a plane, given three points ina plane, Parameter lines and parameter planes, Plotting a plane, The implicit form of equation of a plane, Generating a swept surface, Generating a surface of revolution Wire frame surfaces surface Tangents and normal: Partial differentiation: General surfaces, Forming a wire frame, Carved surfaces from the, Partial differentiation, Surface tangents and surface normal. Piecewise surfaces Quadrilateral patches: Dividing up surfaces, A quadrilateral patch on a sphere, Bilinear patches, Linear Coons patches.5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
   to attain the COs and POs

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Computer Graphics, Mathematical first steps, P A Eagerton and W S Hall, Prentice Hall, Europe,1998, ISBN: 0-13-599572-8 2 CAD/CAM Concepts and Applications,
2. Chennakesava R Alavala, 1st Ed PHI, New Delhi, 2009 ISBN 978-81-203-3340-6 3
3. CAD/CAM Principles and Applications, P.N. Rao, 3rd Ed., McGraw Hill, Education Pvt Ltd., New Delhi ISBN 0-07-058373-0
4. Mastering CAD/CAM, Ibrahim Zeid, 2nd Ed., TMH Publishing Company Limited., New Delhi, ISBN 0-07-0634334

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	Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form	4
CO2	Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and determine the(absolute) stability of a closed-loop control system	5
CO3	Formulate different types of analysis in frequency domain to explain the nature of stability of the system.	5
C04	Apply root Locus technique to analyse and design control systems.	5
C05	Solve systeme quations in state-variableform(statevariablemodels)	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	2	1
CO2	3	3	3	3	2	2	1	2	2	2
CO3	2	2	3	3	2	2	2	2	2	1
CO4	3	3	3	3	2	2	3	3	1	1
CO5	2	2	2	3	3	3	3	2	2	2

Advanced Finite Element Methods			
Course Code	22CAE15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs + 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To implement the basics of FEM to relate stresses and strains.

Module-1

Finite Element Methods-A review Governing differential equations of one- and two dimensional problems, Library of one dimensional and two dimensional elements; Gauss Quadrature and isoparametric elementsStress, Calculation and Gauss points-Convergence requirements and Patch test Bending of Plates and Shells Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements – Thin and Thick Plates- Confirming and non-Confirming Elements – C0 and C1 Continuity Elements – Shell elements as degenerate 3D stress elements-Applications. 5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Three dimensional solids Introduction - Tetrahedra element - Hexahedron element-Linear and higher order elements - Elements with curved surfaces Special Purpose elements Crack tip elements – Transition elements, Finite strip elements-Strip element methods- Method of infinite domain – nodeless elements - 5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Nonlinear Analysis Introduction to nonlinear analysis- Material Nonlinearity-Plasticity-Creep-Visoplasticity-Nonlinear constitutive problem in solid mechanics- Various yield considerations-solution procedures direct-iteration method, Newton Raphson method and Modified newton raphson method Application in Any One manufacturing process 5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Nonlinear Analysis -Geometrical nonlinearity Large deflection and instability-Iteration solution of nonlinear, equations; General incremental nonlinear equation-Lagrange description of motion-Deformation gradient tensor-Velocity gradient tensor-Strain tensor-Stress tensor-Basic expression of the total and updated Lagrangian, formulations-Total and updated Lagrangian formulations – Application in Any One manufacturing process.

5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Dynamic Analysis Lumped and consistent mass matrices - Damping matrix - Free, Transient and Forced response - Solutions of Eigen-systems - Implicit methods for transient dynamics - Mode superposition - Sub space Iterative Technique - Houbolt, Wilson, Newmark - Methods - Examples

5Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

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

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

Semester End Examination:

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

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Suggested Learning Resources:

Books

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt,Concepts and Applications of Finite Element Analysis,John Wiley & Sons, Incl.,2002
2. O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu, Finite element method: Its Basic and fundamentals- 2013, Butterworth Heinemann.
3. Bathe K.J. Finite Element Procedures. Prentice Hall, 2006.
4. S.S.Rao, Finite element method in Engineering, Butterworth Heinemann,2011
5. J.N.Reddy, An introduction to nonlinear finite element analysis, Oxford University Press,2013

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	Analyse linear, nonlinear and simple time-dependent problems in structural discipline using finite elementmethods	5
CO2	Undertake some projects on large deformation and transient nature	4
CO3	Develop some special FEA codes for solving nonlinear problems	5
C04	Estimate the errors in Finite Element Analysis	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**1**	**2**	**1**
CO4	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**1**	**2**	**1**

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

Course Learning objectives:

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

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area,Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

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

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

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests ofHypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit,

Cautions in Using ChiSquareTests. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

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

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers‟ Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation(WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules,Patents,Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

- Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.
- Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.
- Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September2013.
- Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
- Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

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	Discuss research methodology and the technique of defining a research problem	5
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review	4
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	4
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	4
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leadingInternational Instruments concerning IPR	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**3**	**1**
CO2	**2**	**2**	**3**	**2**	**3**	**1**	**1**	**2**	**2**	**1**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**1**
CO5	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**3**

Computer Aided Engineering Laboratory -1

Course Code	22CAEL17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

To implement the basics of Computer Aided Engineering in tensile, flexural, and bending tests.

Sl.NO	Experiments
1	**Experiment #1Experimental and Numerical Analysis of Tensile Test** Part A: Experimental study of Tensile Test Part B: Numerical Analysis of Tensile Test.
2	**Experiment #2 Experimental and Numerical Analysis of Flexural Test** Part A: Experimental study of Flexural Test Part B: Numerical Analysis of Flexural Test
3	**Experiment #3 Numerically Calculation and MATLAB Simulation** Part A: Invariants, Principal stresses and strains with directions Part B: Maximum shear stresses and strains and planes, Von-Mises stress Part C: Calculate and Plot Stresses in Thick-Walled Cylinder
4	**Experiment #4Stress analysis of rectangular plate with circular hole under i. Uniform Tension and ii.Shear** Part A: Mat lab simulation for Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate Part B: Modeling of plate geometry under chosen load conditions and study the effect of plate geometry. Part C: Numerical Analysis using FEA package.
5	**Experiment #5Single edge notched beam in four point bending.** Part A: Modeling of single edge notched beam in four point bending. Part B: Numerical Studies using FEA. Part C: Correlation Studies.
6	**Experimental #6Torsion of Prismatic bar with Rectangular cross-section.** Part A: Elastic solutions, MATLAB Simulation Part B: Finite Element Analysis of any chosen geometry. Part C: Correlation studies.
7	**Experiment #7 Contact Stress Analysis of Circular Disc under diametrical compression** Part A: 3-D Modeling of Circular Discs with valid literature background, supported with experimental results oncontact stress. Part B: Numerical Analysis using any FEA package.Part C: 2D Photo Elastic Investigation.
8	**Experiment #8 Vibration Characteristics of a Spring Mass Damper System.** Part A: Analytical Solutions. Part B: MATLAB Simulation. Part C: Correlation Studies.

Course outcomes:

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

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

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

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

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure

and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

1) NPTEL

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Computer Aided Engineering (CAE)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
Jnana Sangam, Machhe, Belagavi-590018
eMail: registrar@vtu.ac.in
contact: 0831-2498112

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., **Computer Aided Engineering (CAE)**
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	PCC	22CAE21	Advanced CAD	02	00	02	03	50	50	100	3
2	IPCC	22CAE22	Computational and experimental vibration analysis and control	03	02	00	03	50	50	100	4
3	PEC	22CAE23x	Professional Elective -1	02	00	02	03	50	50	100	3
4	PEC	22CAE24x	Professional Elective- 2	02	00	02	03	50	50	100	3
5	MPS	22CAE25	Mini Project with Seminar	00	04	02	--	100	--	100	3
6	PCCL	22CAEL26	Computer Aided Engineering Laboratory -2	01	02	00	03	50	50	100	02
7	AUD/ AEC	22AUD27	Suggested ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
TOTAL				**10**	**08**	**08**	**15**	**350**	**250**	**600**	**18**

Note: PCC: Professional core courses: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project with Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab,
L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities (Hours are for Interaction between faculty and students)

Professional Elective-1		**Professional Elective- 2**	
Course Code under 22MCM23X	**Course title**	**Course Code under 22MCM24X**	**Course title**
22CAE/MCM231	Additive Manufacturing	22CAE241	Mechatronics System Design
22CAE232	CIM & ROBOTICS for Automation	22CAE242	Optimization Methods
22CAE233	Smart Materials And Structures	22CAE/MPM/MPD2	Composite Materials Technology
22CAE234	Vehicle Aerodynamics	22CAE244	Design Of Micro Electro Mechanical Systems
22CAE235/MCM321	Industrial Design and Ergonomics	22MPD/MAU/MDE /MEA/MMD/MTP/ MPX/MIA/MAR/CA	Industry 4.O

Note:
1 Mini Project with Seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.
The CIE marks awarded for Mini-Project work and Seminar, shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question-and-Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course.
2. Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Semester- II

Advanced CAD			
Course Code	22CAE21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

Analyze the Engineering graphics through CAD and Basic manual tools.

Module-1	
CAD Tools: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics, software, Functional areas of CAD, Efficient use of CAD software. Basics of Geometric Modelling Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modelling facilities desired 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Geometric Modelling: Classification of Wire frame entities, surface representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spleen curvewire, NURBS, Curve manipulations. 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Surface Modeling : Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Sp line surface, Blending surface Surface manipulations 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Solid Modelling: Geometry and topology, Boundary representation, The Euler-Poincare formula, Euleroperators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Transformations: 2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface Evaluation Criteria: Evaluation criteria of CAD software, Data exchange formats: GKS, IGES, PHIGS, CGM STEP Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size (RFS). 5Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. CAD/CAM Concepts and Applications/ Alavala/ PHI.
2. Mastering CAD/CAM / Ibrhim Zeid / McGraw Hill International.
3. CAD/CAM Principles and Applications/ P.N. Rao/TMH/3rd Edition
4. CAD/CAM /Groover M.P./ Pearson education
5. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
6. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson
7. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.

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	Describe CAD Tools.	3
CO2	Acquire the knowledge of geometric modeling and Execute the steps required in CAD software for developing 2D and 3D models and perform transformations	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**3**	**3**
CO2	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**

Computational and Experimental Vibration Analysis and Control			
Course Code	**22CAE22**	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. To learn basic principles of finite element analysis procedure .
2. To learn the theory and characteristics of finite elements that represent engineering structures.
3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

MODULE-1

Development of finite element energy functions Axial and torque elements, beam and plate bending elements, membrane element-three dimensional solids-axisymmetric solid- Development of equations of motion and boundary conditions 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-2

Finite element displacement method: Rayleigh-Ritz method-Axial vibration of bars- Torsional vibration of shafts-Bending vibration of beams- Vibration of trusses and frames -Inclusion of shear deformation and rotary inertia effects. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-3

In-plane and flexural vibration of plates: In-plane vibration of plates: Linear triangular element-Linear rectangular element- Linear quadrilateral element- Area coordinates for triangles- Linear triangle in area coordinates. Rectangular and triangular elements- conforming and non-conforming elements. Vibration of Stiffened and Folded Plates: Stiffened Plates- Effect of membrane displacements-Folded Plates 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE-4

Analysis of free and forced vibration: Modal analysis- representation of damping: structural and viscous damping- steady state response to harmonic and periodic excitation- transient response- response to random excitation: response of single degree-freedom, direct and modal response of multi-degree of freedom system-simulation using MATLAB 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

MODULE 5

Control of flexible structures: Control systems- stability theory-stability of multi-degrees of freedom systems-analysis of second order system- transfer function analysis. State space form representation: Control law design for state space system-linear quadratic regulator-modal control for second order systems-dynamic observer-MATLAB commands for control calculations. Experimental methods: Vibration exciters and measuring instruments- Free and forced vibration tests-Measurement of Damping- Industrial case studies and Contemporary Discussion 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

Sl.NO	Experiments
1	Performing a Typical ANSYS Analysis
2	Bars of Constant Cross-section Area
3	Stress analysis of a rectangular plate with a circular hole
4	Simply Supported Beam with Uniformly distributed load
5	Corner angle bracket
6	Fixed- fixed beam subjected to forcing function

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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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 experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

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

SEE for IPCC

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

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. Maurice Petyt, –Introduction to finite element vibration analysis‖, Cambridge University Press, 2010.
2. K.Ogata, –Modern control engineering‖, Prentice Hall, 2010.
3. S.S.Rao, –The finite element method in engineering‖, 6th Edition, Butterworth-Heinemann, 2017.
4. J.N.Reddy, —An introduction to finite element method‖, McGraw Hill, 2005.
5. S.Graham Kelly, –Theory and problems of mechanical vibrations‖, McGraw Hill, 1996.
6. Richard C. Dorf and Robert H. Bishop, –Modern control system‖, 13th Edition, Pearson Education, 2016.
7. C.Sujatha, —Vibration and Acoustics: Measurement and Signal Analysis‖, McGraw Hill, 2010

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

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

- 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	Develop comprehensive knowledge in the fundamental mathematical and physical basis of finite elementmethods.	5
CO2	Know how to build FEM models of physical problems exposed to vibration and apply appropriateconstraints and boundary conditions.	4
CO3	Develop and exercise critical thinking in interpreting results from FEM analysis such as the ability to identify the mode shapes, stress contours, eigen frequency as well as response characteristics.	5
CO4	Connect the disciplines of vibration and control on a firm mathematical basis, and study vibration controlproblems using MATLAB software.	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**1**	**1**
CO3	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**1**	**1**

Professional Elective-I

ADDITIVE MANUFACTURING

Course Code	22CAE/MCM231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology
2. Gain insights on the need, advantages and limitations of additive manufacturing (AM) versus traditional manufacturing
3. Find out the various applications of AM, Deployment levels, Innovative and optimized product design
4. To explore the potential of additive manufacturing in different industrial sectors.
5. To apply 3D printing technology for additive manufacturing.

Module-1

Introduction: Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

REVERSE ENGINEERING AND CAD MODELLING : Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modelling techniques: Wire frame, surface and solid modelling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS : Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modelling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

POWDER BASED ADDITIVE MANUFACTURING SYSTEMS : Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

OTHER ADDITIVE MANUFACTURING SYSTEMS : Three-dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
6. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
7. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.

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	The students are expected to learn about a variety of Additive Manufacturing (AM) technologies.	5
CO2	Describe additive manufacturing and explain its advantages and disadvantages	5
CO3	Explain the processes used in additive manufacturing for a range of materials and applications	5
CO4	understand the role of additive manufacturing in the design process and their potential to support Design and manufacturing,	5
CO5	Case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**3**	**32**	**2**	**2**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**1**	**2**
CO3	**3**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**1**	**1**	**3**
CO5	**3**	**3**	**2**	**1**	**3**	**3**	**3**	**2**	**1**	**2**

Professional Elective-I			
CIM & ROBOTICS for Automation			
Course Code	22CAE232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Students will be introduced to CAD/CAM/CAE concepts.
2. Student will learn steps in upgrading from FMS to CIM.
3. Students will learn about importance of data generation and management in CIMS.

Module-1

Introduction to Computer integrated Manufacturing Systems: Manufacturing Systems, Types of Manufacturing Systems, , Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, The Product Cycle and CAD/ CAM, Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems, NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems:
Machine Control Unit , CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors, Feedback Devices: Encoder, Resolver, Inductors, Tachometers, Counting devices, Digital to analog converters. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Part programming: Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming. Computer Controls in NC: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control (DNC Systems): Configuration of DNC system, Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC, Adaptive control machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Introduction to Robotics: Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies. Concepts and Model about Basic Control System, Transformation and Block Diagram of Spring Mass System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Different Types of Controllers, Control Approaches of Robots. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Kinematics of Robot Manipulator: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co- Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Robotic Workspace, Motion Trajectory & Industrial Applications: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. Robotic Motion Trajectory Design: Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories:-4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories. Industrial Applications: Automation in Manufacturing, Robot Application in Industry, Task Programming, Goals of AI Research, AI Techniques, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges and Case Studies. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. GROOVER M P, Automation, Production Systems and Computer Integrated Manufacturing - , Prentice Hall India (P) Ltd, 1989.
2. Mikell P. Groover and Emory W. Zimmer, Jr., CAD/CAM Computer Aided Design and Manufacturing, Prentice Hall India (P) Ltd, 1992.
3. M.Koren —Computer Controls of Manufacturing Systems, McGrawHill, 1983
4. —A Robot Engineering Textbook — – Mohsen Shahinpo or – Harper & Row publishers,
5. —Robotics, control vision and intelligence, ‖ Fu, Le e and Gonzalez. McGraw Hill International,1987.
6. —Introduction to Robotics:Mechanics and Control ‖ , J ohn J. Craig, Pearson, 3e, 2009.

Reference Books

1. Martin J. —Numerical control of machine tools ‖ .
2. P.N. Rao – CAD/CAM Principles and ApplicationsMcGra whill 2002
3. Y. Koren&J.Benuri -—Numerical control of machine tools-Khanna, 1992
4. Wilson F.M —Numerical control in manufacturing- McGraw Hill Newyork
5. Suk-Hwan Suh, Seong-Kyoon Kang, Dea-Hyuk Chung and Ian Stroud, Theory and Design of CNC Systems,
6. , Springer, 2008.
7. Robotics for Engineers ‖ , YoramKoren, McGraw Hill International, 1985.
8. Industrial Robotics ‖ ,Groover, Weiss, Nagel, McGrawHill International, 1986.
9. Robot Technology Fundaments ‖ - Keramas, Thomson Vikas Publication House, 1999.

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	To impart the basic concepts in manufacturing systems and fundamentals of NC & CNC system	5
CO2	Enhance knowledge in design consideration and increasing productivity with NC machine tools, machiningcenters and tooling for CNC machines	5
CO3	To Understand the robotic system, available tools and technique for kinematics and its applications toindustry	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**1**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**

Professional elective 1			
Smart Materials And Structures			
Course Code	22CAE233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
Understand various smart material and its importance in engineering application.
To Know various processing technics of smart materials.

Module-1

Smart Structures: Types of smart structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, depoling and coersive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor. Beam modeling: Beam modeling with induced strain rate effects, inchworm linear motor beam modeling with induced strain actuation-single actuators, dual actuators, pure extension, pure bending harmonic excitation,
Bernoulli-Euler beam model, problems, piezo-electrical applications.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Shape memory Alloy: Experimental phenomenology, shape memory effect, phase transformation, Tanaka's constitutive model, testing of SMA wires, vibration control through SMA, multiplexing. Applications of SMA and problems. ER and MR fluids: Mechanisms and properties, fluid composition and behavior, the Bingham plastic and related models, pre-yield response, post-yield flow applications in clutches, dampers and others.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Vibration absorbers: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications. Control of structures: Modeling, control strategies and limitations, active structures in practice.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

MEMS: Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Devices: Sensors and Actuators, conductivity of Semiconductors, crystal planes and orientation, Stress and Strain Relations, Flexural Beam Bending Analysis under simple loading conditions, polymers in MEMS, optical MEMSapplications.08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

- Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York,1992 (ISBN: 0412370107).
- Smart Structures and Materials - B. Culshaw, ArtechHouse, Boston, 1996(ISBN : 0890066817).
- Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267
- Electro ceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
- Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin;New York, 2002 (ISBN: 3540422595).
- Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
- Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
- ShapeMemoryMaterials-K.OtsukaandC.M.Wayman,CambridgeUniversityPress, Cambridge; New York, 199~ (ISBN:052144487X).

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 behavior and applicability of various smart materials.	4
CO2	Design simple models for smart structures & materials.	5
CO3	Devise experiments to verify the predictions.	3
CO4	Judge the appropriate application of smart materials with respect to the feasibility of their fabrication andimplementation, and to the economic aspects	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**1**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**1**	**2**
CO3	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO4	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**3**	**3**

Professional Elective-I			
Vehicle Aerodynamics			
Course Code	22CAE234	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To discover patterns in the user data and then make predictions based on these and intricate patterns for answering business questions and solving business problems.

Module-1

Introduction to Road Vehicle Aerodynamics Basic principles of road vehicle aerodynamics; evolution of road vehicles, borrowed shapes, streamlining era, parametric studies, one volume bodies, bathtub bodies, commercial vehicles, motorcycles; shape and detail optimization; futuristic trends; performance analysis of cars and light Trucks. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

In Motion dynamics vehicle equation of motion; aerodynamic drag; tire rolling resistance; climbing resistance; effective mass; traction diagram; acceleration capability and vehicle elasticity; fuel consumption and economy; gear-ratio re-matching; EPA driving cycles – urban, highway, combined; low fuel consumption strategies. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Directional Stability, Safety and Comfort Flow field around a vehicle; interior and exterior flows; attached, separated and oscillating flows; aerodynamic forces and moments; cornering and side wind behaviors; stability index; passing maneuvers; spoiler design; safety and aesthetics; water and dirt accumulation; visibility impairment; ventilation, air flow and odor removal. Engine and interior cooling; radiators; HVAC systems. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Race Car, High performance and Commercial Vehicle Race cars: Front wings, Rear wings, Weight distribution, Over steer and Under steer, Center of 80 gravity effects, Split streaming. Commercial vehicle aerodynamics: Truck Aerodynamics, Improvements in design, Different styles of trailers. Effect of gap between truck and trailer, fairings. Measurement and Testing Techniques Wind tunnel and on-road testing techniques; classification and design of wind tunnels; instrumentation and data acquisition; wind tunnel components and corrections; road testing methods; cross-wind and engine cooling tests; soiling, water and dirt accumulation visibility measurements on road; wind noise models, analysis and measurement. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Computational Fluid Dynamics and Applications Introduction to CFD analysis; CFD vs. experimentation; Fundamentals of fluid mechanics; Continuity, Navier-stokes and energy equations; Modeling and Discretization techniques; basic steps in CFD computation; 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks; turbulence models; Eddy viscosity and non-eddy viscosity models; RANS and ARSM models; LES and DNS methods. Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid-free simulation technique; simulation in climatic and

acoustic wind tunnels; velocity vector and pressure contour simulation; animation of air-flow and fluid-body interaction. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Theory and Applications of Aerodynamics for Ground Vehicles- T. Yomi Obidi. Published by SAE, 2014, ISBN 978-0-7680-2111-0.
2. Competition Car Aerodynamics, A Practical Hand Book, 3rd Edition, Simon McBeath, Willem Toet, Published by Veloce Publishing, 2015 ISBN 978-1845847760.
3. Aerodynamics of Road Vehicles, W.H.Hucho, Published by SAE International, 2015.
4. Low Speed Wind Tunnel Testing, 3rd Edition, Jewel B. Barlow, William H. Rae Jr., Alan Pope, Wiley India Pvt Ltd, 2010.

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	To understand the aerodynamics of vehicles	5
CO2	To apply principles of dynamics in real time vehicles.	5
CO3	To apply different techniques to measure and test vehicles on-road and in test labs.	5
CO4	Employ CFD to understand the flow behavior over the road vehicle model.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	3	2	2	2	2	1	1
CO2	3	3	3	3	3	3	2	2	2	2
CO3	3	3	3	2	2	1	1	2	2	3
CO4	3	3	3	2	2	3	3	2	1	1

INDUSTRIAL DESIGN & ERGONOMICS

Course Code	**22MEM334/CAE235**	CIE Marks	**50**
Teaching Hours/Week (L:P:SDA)	**3:0:0**	SEE Marks	**50**
Total Hours of Pedagogy	**40**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Learning objectives: The course aims to provide an overview of ergonomics principles. A comprehensive view of ergonomics applied in various domains like industrial cognitive and interaction will be covered. The course will help in understanding the design aspects of ergonomics and their applications in real-world problems through case studies and studio sessions.

Module-1

Introduction: An approach to industrial design - elements of design structure for industrial design in engineering application in modem manufacturing systems. Ergonomics and Industrial Design: Introduction - general approach to the man-machine relationship- work station design-working position. **08HRs**

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Control and Displays: shapes and sizes of various controls and displays-multiple displays and control situations - design of major controls in automobiles, machine tools etc., - design of furniture - designof instruments. **08HRs**

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

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Ergonomics and Production: Ergonomics and product design ergonomics in automated systems- expert systems for ergonomic design, Anthropomorphic data and its applications in ergonomic design limitations of anthropomorphic data-use of computerized database**... . 08HRs**

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Visual Effects of Line and Form: The mechanics of seeing psychology of seeing, general influences of lined and form. Colour: colour and light - colour and objects - colour and the eye colour consistency - colour terms - reactions to colour and colour continuation - colour on engineering equipments. **08HRs**

8Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Aesthetic Concepts: Concept of unity - concept of order with variety - concept of purpose style and environment - Aesthetic expressions. Style-components of style - house style, observations style in capital goods. **Industrial Design in Practice:** General design - specifying design equipments - rating the importance of industrial design – industrial design in the design process. **08HRs**

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Text Books

(1)Industrial design for Engineers - Mayall W.H. - LondonCliffee Books Ltd.

(2)Applied Ergonomics Hand Book - Brien Shakel (Edited) - Butterworth Scientific,

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://academicearth.org/
- http://www.bookstreet.in.
- 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	Understanding the concepts of Industrial design and man-machine relationship.	
CO2	Design of optimistic display and control devices for various applications.	
CO3	Applying the anthropomorphic data in ergonomic design.	
CO4	Understanding the visual effects of lines, form and color on engineering equipments.	
CO5	Choosing appropriate aesthetic aspects for design of industrial machinery and evices.	

Program Outcome of this course
Programme Outcome:

PO1 - An ability to independently carry out research /investigation and development work to solve practical problems.

PO2 - An ability to write and present a substantial technical report/document.

PO3 - 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

PO4 - Understand contemporary issues in management and develop relationship between engineering and management practices

PO5 – develop the understanding of various quantitative techniques and approaches to solve management problems

PO6 – ability to understand the techniques of marketing management and marketing research

PO7 –familiarization with roles and responsibilities of a manager in engineering practice

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	2	2	3	2	2
CO2	1	2	2	2	2	2	2
CO3	2	2	2	3	2	3	3
CO4	2	3	1	2	3	3	1
CO5	2	3	3	2	2	3	2

Professional Elective-2			
Mechatronics System Design			
Course Code	22CAE241	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:
Mechatronics Design aims to provide students with knowledge, skills, and exposure to the integrated design process of mechatronics systems

Module-1

Introduction: Definition and introduction to Mechatronic Systems. 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 systems,Electrical actuation systems, Real time interfacing and hardware components for Mechatronics. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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, electro-mechanical systems, hydro- mechanical systems, pneumatic systems. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 Micro systems: Introduction, working principle, materials for MEMS and Micro systems, Micro system fabrication process, overview of Micro Manufacturing, Micro system Design, and Micro system packaging. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Data Presentation Systems: Basic System Models, System Models, and Dynamic Responses of System 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Advanced Applications in Mechatronics: Fault Finding, Design arrangements and practical case studies, Design for manufacturing, User- friendly design 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. W. Bolton, ―Mechatronics‖ - Addison Wesley Longman Publication, 1999 2. HSU ―MEMS and Microsystems design and manufacture‖ - Tata McGraw-Hill Education, 2002
2. Kamm, ―Understanding Electro-Mechanical Engineering an Introduction to Mechatronics‖ - IEEE Press, 1 Edition, 1996
3. Shetty and Kolk ―Mechatronics System Design‖ - Cengage Learning, 2010
4. Mahalik ―Mechatronics‖ - Tata McGraw-Hill Education, 2003
5. HMT ―Mechatronics‖ - Tata McGraw-Hill Education, 1998
6. Michel .B. Histand& David. Alciatore, ―Introduction to Mechatronics & Measurement Systems‖– . Mc Grew Hill, 2002
7. Fine Mechanics and Precision Instruments‖ - Pergamon Press, 1971.

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	Describe mechatronic systems and overview of control systems & actuators.	5
CO2	Differentiate between various sensors, transducers and actuators and their applications	4
CO3	Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logiccontrollers.	4
CO4	Explain the principle of operation of ac induction motor, dc motor, servomotor and stepper motor	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**1**	**2**	**3**
CO2	**3**	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**2**

Professional Elective-2			
Optimization Methods			
Course Code	22CAE242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

Students will study main concepts of optimization theory and develop a methodology for theoretical investigation of optimization problems.

Module-1

Classical Optimization techniques: Introduction, methods, engineering applications of optimization Statement of an optimization problem-classification of optimization problems-Single variable optimization Multivariable optimization with no constraints-Multi variable optimization with equality and in equality constraints: Lagrange multipliers method, Kuhn-Tucker conditions 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

One-Dimensional Nonlinear Optimization: Unimodal function – Region elimination methods: Unrestricted search, Dichotomous Search, Fibonacci method, Golden Section method Unconstrained Nonlinear Optimization: Direct Search methods: Univariate method, Pattern directions, Hook and Jeeves' method, Powell's method-Indirect search methods: Gradient of a function, Cauchy method Fletcher-Reeves method .05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Constrained Non-linear Optimization: Characteristics of a constrained optimization problem - Direct methods: Cutting plane method, methods of feasible directions – Indirect methods: Interior and exterior penalty function methods. Quadratic programming: Introduction-applications-necessary conditions-solution to quadratic programming problem using Wolfe's method 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Geometric programming: 5Introduction to Geometric programming – Solution from differential calculus point of view – Solution from arithmetic-geometric inequality point of view. Advanced Non-linear Optimization. Genetic Algorithms Working Principles- Genetic operator- Numerical problem-Simulated Annealing-Numerical Problem-Neural network based optimization – optimization of fuzzy systems-fuzzy set theory-computational theory- 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Design Optimization of Machine Elements: Functional requirements- desirable and undesirable effects –material and geometrical parameters – adequate designs, Optimum design – primary design equation, subsidiary design equations, limit equations – basic procedural steps for methods of optimum design – constrained parameters and free variables – normal, redundant and incompatible specifications general planning. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Singiresu S. Rao, Engineering Optimization - Theory and Practice, John Wiley & Sons, Inc., 2009
2. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, PHI Learning Pvt. Ltd., 2012.
3. Wilhelm Forst, Dieter Hoffmann, Optimization - Theory and Practice, Springer, 2010.
4. Ravindran, G. V. Reklaitis, K. M. Ragsdell, Engineering Optimization: Methods and Applications, John Wiley & Sons, 2006.

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	Formulate the design problem in mathematical form which can be solved by suitable optimization algorithm.	5
CO2	Solve the design problem which involves non-linear constraints	5
CO3	Compare the efficiency of different algorithms	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	2	2	1	1	2
CO2	3	3	3	3	2	2	1	2	3	2
CO3	2	2	1	2	3	1	2	2	3	2

Professional Elective-2

Composite Materials Technology

Course Code	22CAE/MPM/MPD243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

Equip students with knowledge on composite strengthening addition of components and their production routes. Familiarize students about the properties and response of composite structures subjected to mechanical loading.

Module-1

Introduction to Composite Materials:Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.

Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants fororthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law fortwo-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation,Numerical problems. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.Experimental Characterization of Lamina- Elastic Moduli and Strengths. Failure Criteria: Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensortheory, Numerical problem, practical recommendations.05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Macro Mechanical Analysis of Laminate: Introduction, code, Kirchhoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation)

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Analysis of Composite Structures: Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning compositedisks, composite lattice structures.
Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Manufacturing and Testing: Layup and curing - open and closed mould processing, Hand lay-up techniques,Bag moulding and filament winding. Pultrusion, Pulforming, Thermo forming, Injection moulding, Cutting, Machining, joining and repair.NDT tests – Purpose, Types of defects, NDT method - Ultrasonic-inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Material s & Structures, Universities Press, 2004.
3. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004.
4. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
5. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
6. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw HillInternational, 2009.
7. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.
8. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.
9. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

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 use of fibre -reinforced composites in structural applications	5
CO2	Develop a basic understanding of the use of composite materials, micro-mechanics of layered composites,analysis and design of composite structures and failure analysis of laminated panels	4
CO3	Apply the basic micro-mechanics theories in the design of fibre reinforced composites.	3
CO4	Analyze the performance of composites in engineering applications.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**
CO3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Professional Elective-2			
Design Of Micro Electro Mechanical Systems			
Course Code	22CAE244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To learn about Micro Electro-Mechanical Systems, Micro fabrication and Micromachining, Thermal and Fluidic Micro Sensors and Actuators, and Surface Micromachining

Module-1

Introduction: Micro Electro-Mechanical Systems, Ultra Precision Engineering, Micro-sensors; Micro-actuators; Microelectronics Fabrication; Micromachining; Mechanical MEMS; Thermal MEMS, MOEMS, Magnetic MEMS, RF MEMS, Micro-fluidic Systems, Bio and Chemo Devices.
.05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Micro fabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding. Mechanical Sensors and Actuators: Principles of Sensing and Actuation; Beam and Cantilever; Microplates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements, Strain Measurement, Pressure measurement
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Thermal and Fluidic Micro Sensors and Actuators : Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, Micro actuator examples, Micro Fluidic systems, Fluid actuation methods, micro valves, micro pumps, micromotors- Microactuator systems.
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Surface Micromachining: One or two sacrificial layer processes, Surface micro machining requirements, Polysilicon surface micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectricmaterials. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

MEMS: Characterization: Technologies for MEMS characterization, Scanning Probe Microscopy (SPM):Atomic Force Microscopy (AFM), Scanning tunneling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope.
05 Hrs

Teaching-Learning	Chalk and talk method / PowerPoint Presentation

Process	

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning PrivateLimited, 2009.
2. Stephen D. Senturia, "Microsystem Design" Springer, 2001.
3. MarcMadou, —Fundamentals of Microfabrication‖ Taylor& Francis Group, 2002.
4. Gregory Kovacs, —Micromachined Transducers Source book‖ McGraw Hill 1998.
5. M.H. Bao, —Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes Handbook, Elsevier.
6. NadimMaluf, An Introduction to Microelectromechanical Systems Engineering, Artech House Publishers, 2000.
7. Stephen D. Senturia, "Microsystems Design" Kluwer Academic Publishers, New York.

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	Students will be in a position to demonstrate their knowledge in micro machining and micro electromechanical systems.	5
CO2	Students will come to know about application of memes in manufacturing sector.	5
CO3	Will acquire the knowledge about working of different memes devices	5
CO4	Students will come to know characteristics of different memes devices and its application	5
CO5	Develop new ideas and applications for MEMS devices.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**1**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**
CO4	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**

Professional elective 4			
INDUSTRY 4.0			
Course Code	22MPD/MAU/MDE/MEA/MMD/MTP /MPY/MIA/MAR/CAE/MPE/MPM/M CM245	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 08Hrs

Teaching-Learning Process	**Teaching-Learning Process**

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. 08Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-3

Technology Roadmap for Industry 4.0 : Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.

08Hrs

Teaching-Learning Process	**Teaching-Learning Process**

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. 08Hrs

Teaching-Learning Process	**Teaching-Learning Process**

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, 08Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

1. VTU e-Shikshana Program
2. 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
CO 1	Apply Newton's equation of motion and energy methods to model basic vibrating mechanical system,model undamped and damped mechanical systems and structures for free and harmonically forced vibrations.	5
CO 2	Model single-and multi-degree of freedom for free and forced vibrations and determine response tovibration, natural frequencies and modes of vibration.	4
CO 3	Apply the fundamentals of vibration to its measurement and analysis.	5
CO 4	Solve realistic vibration problems in mechanical engineering design that involves application of most ofthe course syllabus.	5
CO 5	Ability to design and develop vibrations and noise control systems	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**3**
CO3	**3**	**3**	**2**	**3**	**3**	**2**	**1**	**2**	**2**	**3**
CO4	**3**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**2**	**3**
CO5	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**

MINI PROJECT WITH SEMINAR			
Course Code	22CAE25	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:4:2	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	--

Course Learning objectives:

1. Support independent learning.
2. Guide to select and utilize adequate information from varied resources maintaining ethics.
3. Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
4. Develop interactive, communication, organisation, time management, and presentation skills.
5. Impart flexibility and adaptability.
6. Inspire independent and team working.
7. Expand intellectual capacity, credibility, judgement, intuition.
8. Adhere to punctuality, setting and meeting deadlines.
9. Instil responsibilities to oneself and others.
10. Train students to present the topic of project work in a seminar without any fear, face audience confidently,enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: 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 involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.

Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Computer Aided Engineering Laboratory -2			
Course Code	22CAEL26	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

To learn about the Geometric Instability, Viscoelasticity, Forming of Sheet, and Evaluation of Piezoelectric Actuator Goal.

Sl.NO	Experiments
1.	Geometric Instability (Buckling): Buckling of Arch Purpose: Run both linear and nonlinear buckling analyses of an arch. Goal: Become familiar with the procedure for performing eigenvalue buckling, adding a geometric imperfection, and running **nonlinear buckling analysis.**
2.	Viscoelasticity: Compression of Block Purpose: Run an analysis of the compression and release of a rubber block to see creep and recoveryof elastic strains. Goal: Become familiar with input and post processing of viscoelastic materials
3.	Forming of Sheet Purpose: Run a creep problem which uses power law creep on a pressure-loaded metal sheet.Goal: Solve a model with implicit creep which experiences an applied pressure. Become familiar with creep limit cutback contro**l.**
4.	Plate with Hole Purpose: Compare Mises and Hill yield criteria. Goal: Solve a nonlinear analysis of three plates with holes
5.	Thermal-Electric-Mechanical Analysis of Thermal Actuator Goal: To perform a thermal-electrical-mechanical evaluation of a MEMS thermal actuator
6.	Evaluation of Piezoelectric Actuator Goal: To evaluate a piezoelectric actuator – Static analysis to determine the deflection – Modal analysis determine lowest modes and frequencies – Harmonic analysis to determine the deflection caused by an alternating current
7.	Surface Based Constraint Using Contact with MPC Option Purpose: Demonstrate how to use the new contact MPC option for applying a surface basedconstraint to a structure. Goal: Apply a translational and rotational displacement load to a structure and simulate both a rigidand flexible response (similar to CERIG and RBE3 type behaviours)

Course outcomes:

Apply/develop solutions or to do research in the areas of Design and simulation in Mechanical Engineering.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation (CIE):

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

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

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

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

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

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

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure

and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

NPTEL

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Computer Aided Engineering (CAE)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
Jnana Sangam, Machhe, Belagavi-590018
eMail: registrar@vtu.ac.in
contact: 0831-2498112

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., **Computer Aided Engineering (CAE)**
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

III SEMESTER

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	22CAE31	Advanced Machine Design	03	00	02	03	50	50	100	4
2	PEC	22CAE32X	Professional Elective -3	03	00	00	03	50	50	100	3
3	OEC	22CAE33X	Professional elective 4	03	00	00	03	50	50	100	3
4	PROJ	22CAE34	Project Work Phase -1	00	06	00	--	100	--	100	3
5	SP	22CAE35	Societal Project	00	06	00	--	100	--	100	3
6	INT	22CAEI36	Internship	(06 weeks Internship Completed during the intervening vacation of II and III semesters.)			03	50	50	100	6
TOTAL				**09**	**12**	**03**	**12**	**400**	**200**	**600**	**22**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project with Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities** (Hours are for Interaction between faculty and students)

Professional Elective -3		**Professional elective 4**	
Course Code under 22MCM32X	**Course title**	**Course Code under 22MCM33X**	**Course title**
22CAE321	Dynamics And Mechanism Design	22CAE331	Cyber Security For Physical System
22CAE/MCM322	Networking and IoT	22CAE/MPM/332	Supply Chain Management
22CAE323	Nanoscale Modeling And Simulation	22CAE333	Applied Materials Engineering
22CAE324	Computer Aided Manufacturing	22CAE334	Design Of Vibration Control
22CAE325	Reliability and Maintenance Engineering	22CAE335	Work Systems Engineering

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same

during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

3. Internship: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., **Computer Aided Engineering (CAE)**
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)

IV SEMESTER

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	22CAE41	Project Work Phase -2	--	08	03	100	100	200	18
			TOTAL	--	**08**	**03**	**100**	**100**	**200**	**18**

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question-and-Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

Total Credits 22+18+22+18 =**80**

Semester - III

Advanced Machine Design

Course Code	22CAE31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 Hrs+ 10-12 Activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:
Introduce Knowledge about the advance failure theories.
Acquire the Knowledge of Fatigue from Variable Amplitude Loading.

Module-1

Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr' s theory and modified Mohr' s theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Stress-Life(S-N) Approach: S-N curves, Statistical nature of fatigue Test data, General SN behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S- N approach. Strain-Life (ε-N)approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Meanstress effects, Crack growth life estimation.
Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notchedmembranes, mean Stress effects and Haigh diagrams, Numerical examples.
08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life Estimation using stress life approach, Numerical examples.
Notch strain analysis: Strain– life approach, Neuber' s rule, Glinka' s rule, applications of Fracture mechanics tocrack growth at notches, Numerical examples. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Abrasive wear, Corrosion wear. Surface fatigue: spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength, Surface fatigue failure modes, Design to avoid Surface failures.. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

1. RalphI. Stephens,AliFatemi, Robert, Henryo. Fuchs, ― Metal Fatigue in engineering‖ , John Wiley NewYork, Second edition. 2001.
2. Failure of Materials in Mechanical Design, Jack.A. Collins, John Wiley, New York 1992.
3. Robert.L.Norton , ― Machine Design‖ , Pearson Education India, 2000.
4. S.Suresh , ― Fatigue of Materials‖ , Cambridge University Press, -1998
5. Julie.A.Benantine, ― Fundamentals of Metal Fatigue Analysis‖ , PrenticeHall,1990
6. Fatigue and Fracture, ASM Hand Book, Vol .19,2002.

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	Apply state of the art design methodology namely design by analysis and damage tolerant	5
CO2	Distinguish different design criteria and their procedure to carry out the design of	5
CO3	Design machine components which are subjected to fluctuating loads	5
CO4	Design machine components using techniques like stress life approach, Strain life	5
CO5	Define the various statistical aspects of fatigue using different probability distribution	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences,	

	and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	2	2	1	2	3	2
CO2	3	3	3	3	2	1	2	3	2	1
CO3	3	3	2	1	2	3	3	2	3	3
CO4	3	3	2	2	3	3	2	1	2	3
CO5	3	3	2	1	2	3	3	2	1	2

Professional elective 4			
Dynamics And Mechanism Design			
Course Code	22CAE321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To teach students concepts of generalized forces and the Principle of Virtual Work .

Module-1

Geometry of Motion: Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, unique mechanisms Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall – Ault auxiliary point method, Goodman's indirect method, Numerical examples.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Generalized Principles of Dynamics: Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamiltons equations Numerical examples

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle. Numerical examples

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Graphical Methods of Dimensional Synthesis: Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis Cognate linkages Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

System Dynamics: Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation Phase plane Analysis, Response of Linear Systems to transient disturbances Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles. Numerical examples.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

1. K.J.Waldron & G.L.Kinzel , —Kinematics, Dynamics and Design of Machinery||, Wiley India, 2007.
2. Greenwood, —Classical Dynamics, Prentice Hall of India, 1988.
3. J E Shigley, —Theory of Machines and Mechanism|| -McGraw-Hill, 1995
4. A.G.Ambekar , —Mechanism and Machine Theory||, PHI, 2007.
5. Ghosh and Mallick , —Theory of Mechanism and Mechanism||, East West press

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	Apply the tools of analytical dynamics with the main goal of developing	5
CO2	Formulate equations of motion for complicated mechanical systems /linkages and hods	5
CO3	Understand multi body dynamics in mechanical engineering design	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**2**
CO2	**3**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**2**	**3**
CO3	**2**	**2**	**2**	**3**	**2**	**1**	**3**	**2**	**3**	**3**

Professional Elective-3			
NETWORKING AND IOT			
Course Code	22CAE/MCM322	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Able to understand the application areas of IOT
2. Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
3. Able to understand building blocks of Internet of Things and characteristics.

Module-1	
Introduction to IoT Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models &APIs. IoT& M2M Machine to Machine, Difference between IoT and M2M, Software define Network 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Network & Communication aspects Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Challenges in IoT Design challenges, Development challenges, Security challenges, Other challenges. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Domain specific applications of IoT Home automation, Industry applications, Surveillance applications, Other IoT applications. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Developing IoTs Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

(1) IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things.by David Hanes,Cisco Press,2007

(2) Vijay Madisetti, ArshdeepBahga, "Internet of Things: A Hands-On Approach"

Reference Books

(3) (1) Computer Networks; By: Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition 6

(2) Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice

(3) Data and Computer Communications; By: Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition

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	Interpret the design aspects and communication models of IoT.	5
CO2	Examine the design, development, security and deployment challenges pertaining to	4
CO3	Analyze the media access control protocols, routing protocols and node discovery	4
CO4	Explain the data dissemination and aggregation techniques used by IoT sensors.	5
CO5	Examine the domain specific IoT applications.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**
CO3	**3**	**3**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**2**
CO4	**3**	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**3**	**3**
CO5	**2**	**2**	**2**	**3**	**3**	**2**	**1**	**2**	**3**	**2**

Professional Elective-3			
Nanoscale Modeling And Simulation			
Course Code	22CAE323	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To learn fundamentals and cutting-edge nature of various simulations methods and their application to nanostructures and nanotechnology.

Module-1

Introduction: Definition of a model, modeling in materials science; Simulation vs. modeling; Simulation techniques for nano, micro, meso and continuum scales; Nanoscale and microscale - molecular dynamics and Monte Carlo techniques

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Statistical Mechanics: Microstate, Macrostate, Distribution Laws, Indistinguishable particles, statistical mechanics and thermodynamics laws; Maxwell Botzmann statistics.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Monte Caro Simulation: Principles of equilibrium; Monte Carlo simulation estimator; Importance of sampling acceptance ratio, continuous time MC, Ising model and Metropolis algorithm; Simulation of Interfaces; Analysis of MC data; Out of equilibrium simulation; MC simulation in surface science; Implementation of MC algorithms.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Molecular Dynamics: Introduction, Interatomic potentials, Equations of motion, integration, Pair Distribution constraints and free energy; Time correlation functions and spherical densities; Velocity autocorrelation functions; Time correlation function and relaxation times; Applications in nano materials

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Overview of Modelling, Simulation and Visualization Software: LAMMPS, ABMER, Folding @ home GROMACS, NAMD, VMD, XMD, Materials Studio

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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

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

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

1. Newman, M.E.J. and Barkema, G.T., —Monte Carlo Methods in Statistical Phyiscs||, Oxford University Press. 1999
2. Lee, J. G., —Computational Materials Science – An Introduction||, CRC Press. 2012
3. Wolfson, M.M. and Pert, G. J., —An Introduction to Computer Simulation||, Oxford Press. 1999
4. Raabe, D., Computational Materials Science: The Simulation of Materials Microstructures and Properties, Wiley-VCH 2005
5. Landau, D.P. and Binder, K., —A Guide to Monte Carlo Simulation in Statistical Physics||, Cambridge University Press. 2005
6. Frenkel, D. and Smith, B., —Understanding Molecular Simulation||, Academic Press. 1996

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	Differentiate between simulation and modelling of nano materials	4
CO2	Apply knowledge of various concepts related to nano sized materials	5
CO3	Implementation of Monte Carlo algorithms for Nano materials	4
CO4	Calculate the interatomic potential for Nano materials	4
CO5	Analyse nano material using different modelling software	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these	

	areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**1**	**2**
CO4	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**
CO5	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**

Professional Elective-3			
Computer Aided Manufacturing			
Course Code	22CAE324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
The students can learn about translation of drawings and data into detailed instructions that drive automated tools/machines.

Module-1	
Computer Aided Programming : General Information, APT Programming, Examples APT Programming problems (2D Machining only) NC Programming on CAD/CAM Systems, the design and implementation of post processors .Introduction to CAD/CAM software, Automatic Tool Path generation. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Tooling for CNC Machines: Interchangeable tooling system, preset and qualified toois, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. ATC, DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, Adaptive control of machining processes like turning grinding 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Post Processors for CNC Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP — based Post Processor, th creation of a DAPP — Based Post Processor. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Micro Controllers Introduction, Hardware components, I/O pins, ports, external memory:, counters, timers and serial data I/O interrupts. Selection of Micro Controllers Embedded Controllers, Applications, and Programming of Micro Controllers. Programming Logic Controllers (PLC' s): Introduction, Hardware components of PLC, System basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters , Applications of PLC's in CNC Machines 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Computer Aided Process Planning Hybrid CAAP System, Computer Aided Inspection and quality control, Coordinate Measuring Machine Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures, Flexible manufacturing, cellular manufacturing.08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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1. Three Unit Tests each of **20 Marks**
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The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

- Computer Control of Manufacturing Systems / Yoram Koren / McGraw Hill. 1983.
- Computer Aided Design Manufacturing – K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, PHI, 2008.
- CAD/CAM Principles and Applications, P.N. Rao, TMH. 4. Alavala, CAD/CAM PHI.
- CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age
- Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson
- Computer Numerical Control Concepts and programming, Warren S Seames, Thomson

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 Computer Aided Programming	5
CO2	Understand Tooling for CNC Machines	5
CO3	Understand Post Processors for CNC	4
CO4	Understand Micro Controllers	5
CO5	Understand Computer Aided Process Planning	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
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	and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	2	1	2	3	2
CO2	3	3	3	2	1	2	2	3	2	1
CO3	3	3	3	2	1	2	2	3	2	1
CO4	3	3	3	2	1	2	2	3	2	1
CO5	3	3	2	1	2	3	2	1	2	3

Professional Elective-3			
Reliability and Maintenance Engineering			
Course Code	22CAE325	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
- Applying of measurement and scaling technique for prototype manufacturing.
- Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning

Module-1

Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation - Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Reliability–Cost trade off, Prediction and analysis, Problems.

08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-2

Maintainability, Availability & Failure Analysis: Introduction, Techniques available to improve maintain ability & availability, trade off among reliability, maintainability & availability and analysis. Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-3

Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/ Repair/ Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-4

Maintenance Systems: Fixed time maintenance, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency ,non – destructive inspection, PERT & CPM in maintenance, Concept of tero technology.

08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-5

Mechanical Fault Diagnosis by Condition Monitoring Techniques: Thermography, Radiography, Ferrography,Acoustic emission monitoring, Noise monitoring.Online monitoring and diagnostic systems. Condition monitoring in power plants, chemical plants and petro chemical plants.

08 Hrs

Teaching-Learning	**Teaching-Learning Process**

Process	

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
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The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

- Optimization theory & Applications / S. S. Rao / New Age International
- Introductory to operation research / Kasan & Kuma r/ Springar
- OptimizationTechniques theory & practice / M.CJoshi, K.M.Moudgalya / Narosa Publications.
- Operation Research / H.A.Taha / TMH
- Optimization in operations research / R. L Rardin.
- Optimization Techniques / Benugundu & Chandraputla / Person Asia.

Web links and Video Lectures (e-Resources):

1. VTU e-Shikshana Program
2. 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 Computer Aided Programming	5
CO2	Understand Tooling for CNC Machines	5
CO3	Understand Post Processors for CNC	4
CO4	Understand Micro Controllers	5
CO5	Understand Computer Aided Process Planning	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
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PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences,	

	and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	3	2	1	2	3	2
CO2	3	3	3	2	1	2	2	3	2	1
CO3	3	3	3	2	1	2	2	3	2	1
CO4	3	3	3	2	1	2	2	3	2	1
CO5	3	3	2	1	2	3	2	1	2	3

Professional elective 4			
CYBER SECURITY FOR PHYSICAL SYSTEM			
Course Code	22CAE331	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To introduce students to cyber-physical systems modeling, analysis, and design.

Module-1

Software and System Security : Control hijacking attacks – buffer overflow, integer overflow, bypassing browser memory protection; Sand boxing and Isolation ;and techniques for writing robust application software; Security vulnerability detection tools, and techniques–program analysis (static, concolic and dynamic analysis); Privilege, Access control, and Operating System Security; Exploitation techniques, and Fuzzing.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Network Security & Web Security: Security Issues in TCP/IP – TCP, DNS, Routing (Topics such as basic problems of security in TCP/IP,, IPsec, BGP Security, DNS Cache poisoning etc) Network Defense tools – Firewalls, Intrusion Detection, Filtering DNSSec, NSec3, Distributed Firewalls, Intrusion Detection tools Threat Models, Denial of Service Attacks, DOS-proof network architecture Security architecture of World Wide Web, Security Architecture of Web Servers, and Web Clients Web Application Security – Cross Site Scripting Attacks, Cross Site Request Forgery, SQL Injection Content Security Policies (CSP) in web Session Management and User Authentication, Session Integrity Https, SSL/TLS.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Security in Mobile Platforms: Android vs. ioS security model, threat models, information tracking, rootkits Threats in mobile applications, analyzer for mobile apps to discover security vulnerabilities Viruses, spywares, and keyloggers and malware detection

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Introduction to Hardware Security, Supply Chain Security: Threats of Hardware Trojans and Supply Chain Security, Side Channel Analysis based Threats, and attacks

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Issues in Critical Infrastructure and SCADA Security: Security issues in SCADA; IP Convergence Cyber Physical System Security threats: Threat models in SCADA and various protection approaches; Machine learning and SCADASecurity.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Assessment Details (both CIE and SEE)

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1. Three Unit Tests each of **20 Marks**
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The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

1. Cybersecurity:Understandingcybercrime,phenomenon,challenges,andlegal responseITUReport, November"2014
2. CyberSecurity:UnderstandingCyberCrimes,ComputerForensicsandLegalPerspectives,ByNinaGodboleandSunitBelapure, WileyIndia

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	Demonstrate physical system security from the cyber attack	5
CO2	Demonstrate network and web security threat models and corrective modules	5
CO3	Demonstrate various mobile platforms discover security vulnerabilities	4
CO4	Understand and analyse the hardware security requirement	5
CO5	Describe the application of SCADA protection approaches	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	

PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	3	3	2	1	2
CO2	3	3	3	2	1	2	3	2	1	2
CO3	3	3	2	1	2	2	2	3	2	1
CO4	3	3	2	1	2	3	3	3	3	1
CO5	3	3	2	1	2	3	2	1	1	1

Professional Elective-3			
SUPPLY CHAINMANAGEMENT			
Course Code	22CAE/MPM/332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To develop an understanding of basic concepts and role of Logistics and supply chain management in business.
2. To understand how supply chain drivers play an important role in redefining value chain excellence of Firms.

Module-1	
Introduction: Definition of logistics and supply chain management, decision phases in a supply chain, objectives of SCM, examples of supply chains, supply chain drivers, supply chain integration, supply chain performance measures. Logistics Network Design: Role of distribution in supply chain, distribution network design, factors influencing distribution network design, distribution networks in practice, network design in the supply chain, factors influencing the network design, framework for network design, models for facility location and capacity allocation, Impact of uncertainty on network design08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Coordinated Product And Supply Chain Design: General framework - design for logistics - standardization – pushpull boundary - supplier integration into new product development - keys to effective supplier integration - mass customization - meaning - mass customization and supply chain management. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Strategic Alliances: Framework for strategic alliances - Third Party Logistics - 3PL issues and requirements - retailer -supplier partnerships - issues in retailer - supplier partnerships - distributor integration - types and issues of distributorintegration. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Inventory Management: Cycle inventory, economies of scale to exploit fixed costs, quantity discounts, example problems, multi-echelon inventory, safety inventory in supply chain, safety level estimation, supply uncertainty, data aggregation, replenishment policies, managing safety inventory in practice, product availability, optimal level, affecting factors, supply chain contracts - Bull whip effect. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Technologies For SCM: Information Technology (IT) - Infrastructure - Interface devices - System architecture - Electronic commerce - IT for supply chain excellence - Service oriented architecture - Radio Frequency Identification (RFID) - Impact of internet. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

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

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

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module
6. .

Suggested Learning Resources:

Books

(1) Simchi - Levi Davi, Kaminsky Philip and Simchi-Levi Edith, "Designing and Managing the Supply Chain", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2012.

(2) Sunil Chopra and Peter Meindl, "Supply Chain Management", Prentice Hall, New Jersey, 2010. (3) Sadler I, "Logistics and Supply Chain Integration", Sage Publishers, 2007.

(4) David J.Bloomberg , Stephen Lemay and Joe B.Hanna, "Logistics" PHI

Reference Books

(1) Jeremy F.Shapiro, "Modeling the Supply Chain", Thomson Duxbury

(2) Srinivasan G.S, "Quantitative models in Operations and Supply Chain Management", PHI,

(3) James B.Ayers, "Handbook of Supply Chain Management", St.Lucle press

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	Demonstrate a clear understanding of the key concepts applied in logistics and supply chain management.	
CO2	To highlight the importance of all activities of the supply chain and an understanding	
CO3	To develop skills for planning, designing the operational facilities of supply chain with the analytical and critical understanding	
CO4	Apply various tools and technics to plan and maintain the inventory	
CO5	Demonstrate application information technology in SCM.	

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**3**
CO2	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**3**	**3**
CO3	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**
CO5	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**1**

Professional Elective-2			
Applied Materials Engineering			
Course Code	22CAE333	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To learn the principles of material testing and characterization and to apply them for various engineering applications

Module-1

Review of basic concepts: Mechanical behavior of Materials, Mechanical properties of materials, stress and strain, Mohr's strain circle, Elasticity, plasticity, Tensile Testing, stress-strain curve for ductile, brittle and polymer materials, Bridgman correction, Other tests of plastic behavior, Strain hardening of metals mechanism. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Fatigue, Fracture and Creep mechanisms: curves, effect of mean stress, stress concentration, design estimates , cyclic stress strain behavior, Ductility and Fracture, slip system, Griffiths theory, Orowan theory, theoretical fracture strength, Irwin's fracture analysis, fracture mechanics in design, Creep mechanisms, temperature dependence of creep 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Modern materials and alloys: Super alloys, Refractory metals, Shape memory alloys, Dual phase steels, Micro alloyed steel High strength low alloy steel, Transformation induced plasticity steel(TRIP steel), Maraging steel Smart materials, Metallic glass, Quasi crystal, Nano-crystalline materials, metal foams, Compacted graphite cast iron and creep resistant aluminum alloys 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Surface modifications of materials: Mechanical surface treatment and coating, Case hardening and hard facing , Thermal spraying, Vapor deposition and ion implantation, Diffusion coating, electroplating and Electrolysis, Conversion coating, Ceramic coating, Organic coatings, diamond coating, Laser based surface modification, Review of Metal Working: Mechanisms of metal working, Flow-stress determination, Temperature in metal , working, strain Rate Effects, Friction and Lubrication, Deformation- zone geometry, Hydrostatic Pressure, Workability, Residual stress 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Forging: Forging equipment, types, forging in plain strain, calculation of forging loads, forging defects, powder, metallurgy forging, and Residual stresses in forging. Rolling: Classification, Rolling of bars and shapes, Forces and geometrical relationship, calculation of rolling loads, variables and defects in rolling, rolling mill control theories. Extrusion and Sheet metal forming: Classification, Analysis of extrusion process, Deformation, lubrication and defects. Forming methods, shearing and blanking, bending, stretch forming, deep drawing, Limit criteria, Defects 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

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

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

Semester End Examination:

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

The students will have to answer five full questions, selecting one full question from each module

.

Suggested Learning Resources:

Books

1. George E. Dieter, Mechanical Metallurgy, Mc Graw Hill, 2013.
2. Norman E. Dowling, Mechanical Behavior of Materials , Prentice Hall, 2012
3. Kenneth G Budenski and Michael K Budenski Engineering Materials' by Prentice-Hall of India Private Limited, 2009.
4. William F. Hosford & Ann Arbor Robert M. Caddell, Metal Forming : Mechanics and Metallurgy,Cambridge University Press, 2011
5. J.E.Dorn, Mechanical behaviour of materials at elevated temperatures, McGraw Hill, 2000.
6. Henry Ericsson Theis, Handbook of Metal forming Processes, CRC Press, 1999

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	Describe the mechanical behavior of metallic systems and its importance	5
CO2	Knowledge on engineering alloys and nonmetallic materials and their selection	5
CO3	Gain knowledge on different types of surface modifications of materials.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**3**	**3**	**2**
CO2	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**2**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**3**	**3**

Professional elective 4			
Design Of Vibration Control Systems			
Course Code	22CAE334	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To learn about Mechanical Vibrations, Transient Vibration of single Degree of freedom systems, and Continuous Systems

Module-1

Review of Mechanical Vibrations Basic concepts: free vibration of single degree of freedom Systems with and without damping, forced vibration of single DOF-systems, Natural frequency Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers, and Vibration dampers.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Transient Vibration of single Degree of freedom systems: Impulse excitation, arbitrary excitation, Laplace transform formulation, Pulse excitation and rise-time, Shock response spectrum, Shock isolation .
Random Vibrations: Random phenomena, Time averaging and expected value, Frequency Response function Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis Modal analysis &Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis.

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Vibration and Noise Control : Basics Of Noise, Introduction, amplitude, frequency, wavelength and sound pressure lavel, addition, subtraction and averaging decibel; levels, noise dose lavel, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis tracking analysis sound quality analysis. Introduction to Automotive noise sources, Engine over-all noise lavels

08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Continuous Systems: Vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams

08 Hrs

Teaching-Learning	Chalk and talk method / PowerPoint Presentation

Process	

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

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

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

Semester End Examination:

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

.

Suggested Learning Resources:

Books

1. S. S. Rao, –MechanicalVibrations‖ , Pearson Education, 4th edition.
2. S. Graham Kelly,– Fundamentals ofMechanicalVibration‖ -McGraw-Hill, 2000
3. Theoryof Vibration with Application, -William T. Thomson, Marie Dillon
4. S. Graham Kelly,– Mechanical Vibrations‖ , Schaum' s Outlines, TataMcGraw Hill, 2007.
5. C Sujatha,– Vibrations and Acoustics – Measurements and signalanalysis‖ , Tata McGraw Hill, 2010

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
CO 1	Apply Newton's equation of motion and energy methods to model basic vibrating	5
CO 2	Model single-and multi-degree of freedom for free and forced vibrations and	4
CO 3	Apply the fundamentals of vibration to its measurement and analysis.	5
CO 4	Solve realistic vibration problems in mechanical engineering design that involves	5
CO 5	Ability to design and develop vibrations and noise control systems	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an	

	understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	1	2	3	2	2
CO2	3	3	2	2	2	2	1	2	2	3
CO3	3	3	2	3	3	2	1	2	2	3
CO4	3	3	2	1	2	2	3	3	2	3
CO5	3	2	2	2	2	2	3	2	2	3

Professional Elective-4			
Work Systems Engineering			
Course Code	22CAE335	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Student obtains a foundational knowledge of systems engineering processes and practices.
2. Student uses the knowledge and information gained in the course to expand and improve the application of systems engineering in their field.

Module-1

Productivity and Work Study: Productivity concepts and definitions, productivity Vs standard of living, Techniques for productivity improvement, Measuring productivity of an enterprise, materials, land, building, machines and man power. Methods Study: Selection of job, record - examine - develop, movement of workers, materials, tools for recording the movement of workers.

05 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-2

Principles of Motion Economy: Classification of movements, two handed process charts, Micro motion study (therbligs), memo motion study, simo chart, chronocycle graph, recording techniques, define-install-maintain

05 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-3

Work Measurement: Definition, basic procedure, techniques, work sampling, determination of sample size, conducting work sampling study, performance rating systems, various types of allowances.

05 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-4

Time Study: Equipment, forms, selecting the job and worker, basic steps, classification of elements, breaking the job into elements, determination of sample size. Techniques for Work Measurements: Stop watch time study, work sampling, PMTS, MTM, analytical estimation.

05 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-5

Influence of Working Conditions in Work Study: Layout and housekeeping, lighting, noise, vibration, ergonomics, fire prevention and protection, OSHA.

05 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

- ILO, "Introduction to Work Study: Indian Adaptation", Oxford and IBH Publishing Company Private Limited,2008.
- Ralph M Barnes, "Motion and Time: Study Design and Measurement of Works", John Wiley & Sons Inc.,2002.
- Benjamin W Niebel, "Motion and Time Study - An Introduction to Methods, Time Study and Wage Payment",Richard Dirwin, Illinois, 1958.
- Barnes,Raeph.m., "MotionandTimeStudy –DesignandMeasurementofWork",John Wiley&sons,New York,1990
- Mc.Cormick,E.J.,"HumanFactorsinEngineeringandDesign",Mc.GrawHill.

Web links and Video Lectures (e-Resources):

3. VTU e-Shikshana Program
4. 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	Students will be in a position to demonstrate their knowledge in micro machining and	5
CO2	Students will come to know about application of memes in manufacturing sector.	5
CO3	Will acquire the knowledge about working of different memes devices	5
CO4	Students will come to know characteristics of different memes devices and its application	5
CO5	Develop new ideas and applications for MEMS devices	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	To prepare students to meet the industrial requirements at global level competitiveness.	
PO2	To develop the students analytical skills to enable them to understand real world problems and formulate solutions.	
PO3	To impart basic education to students in the areas of Design Engineering, Manufacturing Engineering and Thermal Sciences that will enable them to take up higher studies in these areas.	
PO4	To allow students to work in teams through group project works and thus help them achieve interpersonal and communication skills.	
PO5	To inculcate the habit of lifelong learning, adherence to ethics in profession, concern for environmental and regard for good professional practices.	
PO6	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
PO8	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	
PO9	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
PO10	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences,	

	and engineering sciences.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	2	3	3	3	2	2	1
CO2	3	3	3	3	3	2	2	2	1	2
CO3	3	3	3	3	3	2	2	1	2	2
CO4	3	2	2	2	1	2	2	3	3	2
CO5	3	3	3	3	3	2	2	1	2	2

PROJECT WORK PHASE – 1			
Course Code	22CAE34	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	--

Course Learning objectives:

1. Support independent learning.
2. Guide to select and utilize adequate information from varied resources maintaining ethics.
3. Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
4. Develop interactive, communication, organisation, time management, and presentation skills.
5. Impart flexibility and adaptability.
6. Inspire independent and team working.
7. Expand intellectual capacity, credibility, judgement, intuition.
8. Adhere to punctuality, setting and meeting deadlines.
9. Instil responsibilities to oneself and others.
10. Train students to present the topic of project work in a seminar without any fear, face audience confidently,enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: 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 involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.

Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

SOCIETAL PROJECT			
Course Code	22CAE35	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	--

Course Learning objectives:

1. To support independent learning and innovative attitude.
2. To guide to select and utilize adequate information from varied resources upholding ethics.
3. To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
4. To develop interactive, communication, organisation, time management, and presentation skills.
5. To impart flexibility and adaptability.
6. To inspire independent and team working.
7. To expand intellectual capacity, credibility, judgement, intuition.
8. To adhere to punctuality, setting and meeting deadlines.
9. To instil responsibilities to oneself and others.
10. To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Societal-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoidingplagiarism.

Course outcomes:

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

- Present the societal -project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.

Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Societal - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Societal - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Societal - Project report shall be the same for all the batch mates.

INTERNSHIP			
Course Code	22CAEI36	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(06 weeks Internship,To be Completed during the intervening vacation of II and III semesters.)	SEE Marks	50
Total Hours of Pedagogy	--	Total Marks	100
Credits	06	Exam Hours	03

Course Learning objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

1. To put theory into practice.
2. To expand thinking and broaden the knowledge and skills acquired through course work in the field.To relate to, interact with, and learn from current professionals in the field.
3. To gain a greater understanding of the duties and responsibilities of a professional.To understand and adhere to professional standards in the field.
4. To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, clientinteraction, input of ideas, and confidentiality.
5. To identify personal strengths and weaknesses.
6. To develop the initiative and motivation to be a self-starter and work independently.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all theactivities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

SEE marks for the internship report (20 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointedby the University.

PROJECT WORK PHASE -2			
Course Code	22CAE41	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:0:8	SEE Marks	100
Total Hours of Pedagogy	--	Total Marks	200
Credits	18	Exam Hours	03

Course objectives:

1. To support independent learning.
2. To guide to select and utilize adequate information from varied resources maintaining ethics.
3. To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
4. To develop interactive, communication, organisation, time management, and presentation skills.
5. To impart flexibility and adaptability.
6. To inspire independent and team working.
7. To expand intellectual capacity, credibility, judgement, intuition.
8. To adhere to punctuality, setting and meeting deadlines.
9. To instil responsibilities to oneself and others.
10. To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation:

Project Report: 50 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 30 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 20 marks.

The student shall be evaluated based on the ability in the Question and Answer session.

Semester End Examination

SEE marks for the project report (50 marks), seminar (30 marks) and question and answer session (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.