VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus

M.Tech **COMPUTER AIDED ENGINEERING (CAE)**

(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
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	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20CAE11	Mathematical Methods In Engineering	03	--	02	03	40	60	100	4
2	PCC	20 CAE12	CNC System Design	03	--	02	03	40	60	100	4
3	PCC	20 CAE13	Machine Learning	03	--	02	03	40	60	100	4
4	PCC	20 CAE14	Computer Application In Design	03	--	02	03	40	60	100	4
5	PCC	20 CAE15	Advanced Finite Element Methods	03	--	02	03	40	60	100	4
6	PCC	20 CAEL16	Computer Aided Engineering Laboratory -1	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	01	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

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M.Tech COMPUTER AIDED ENGINEERING (CAE)
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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 CAE21	Advanced CAD	03	--	02	03	40	60	100	4
2	PCC	20 CAE22	Computational and experimental vibration analysis and control	03	--	02	03	40	60	100	4
3	PCC	20 CAE23	Computational Fluid Dynamics	03	--	02	03	40	60	100	4
4	PEC	20 CAE24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20 CAE25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20 CAEL26	Computer Aided Engineering Laboratory -2	--	04	--	03	40	60	100	2
7	PCC	20 CAE27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20CAE24X	**Course title**	**Course Code under 20CAE25X**	**Course title**
20 CAE241	CIM & ROBOTICS for Automation	20 CAE251	Optimization Methods
20 CAE242	Composite Materials Technology	20 CAE252	Applied Materials Engineering
20 CAE243	Vehicle Aerodynamics	20 CAE253	Design Of Micro Electro Mechanical Systems

Note:

1. Technical Seminar: 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. Participation in the seminar by all postgraduate students of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or 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. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 CAE31	Advanced Machine Design	03	--	02	03	40	60	100	4
2	PEC	20 CAE32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20 CAE33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20 CAE34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20 CAE35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20 CAEI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under 20CAE32X	**Course title**	**Course Code under 20CAE33X**	**Course title**
20 CAE321	Mechatronics System Design	20 CAE331	Dynamics And Mechanism Design
20 CAE322	Nanoscale Modeling And Simulation	20 CAE332	Smart Materials And Structures
20 CAE323	Computer Aided Manufacturing	20 CAE333	Design Of Vibration Control Systems

Note:

1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

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 Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in 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.

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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	20 CAE41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

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 -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 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.

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MATHEMATICAL METHODS IN ENGINEERING			
Course Code	20CAE11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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.

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.

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.

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.

Module-5

LinearTransformation: Introduction to Linear Transformation, The matrix of LinearTransformation, Linear Models in Science and Engineering Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram-schmidt process, Least Square problems, Inner product spaces.

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003

Reference Books

1. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
2. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.

CNC SYSTEM DESIGN			
Course Code	20CAE12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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

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-code Interpreter.

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.

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**.**

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.

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 SystemDesign ,Main Sequence for Design ,Key Design Factors ,Development of theMachining Cycle. ,Turning Fixed Cycle. ,Turning Cycle for Arbitrary Shape ,CornerMachining Cycle .Drilling Sequence.

Course outcomes:

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

CO1. NC/CNC machines, various elements of CNC machines and its uses.

CO2. Constructional features of CNC machine Tools

CO3. Knowledge of CNC programming and its implementation.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks
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
Reference Books
1. Theory and Design of CNC Systems, Suk-Hwan Suh, SeongKyoon Kang, Dae-Hyuk Chung, Ian Stroud (auth.),Springer Series in Advanced Manufacturing.2008 2. Cad cam cim, 3rd Edition, P. Radhakrishnan (Author), S. Subramanyam, V. RajuNew Age International 3rd edition 2009.

MACHINE LEARNING			
Course Code	20CAE13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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 - 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.

Module-2

Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles - Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing - Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Computational complexity of training. Sample complexity for finite hypothesis spaces. PAC results for learning conjunctions, kDNF, and kCNF. Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis dimension.

Module-3

Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Hornclause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution, Golem, and Progol - Support Vector Machines: Maximum margin linear separators. Quadratic programming solution to finding maximum margin separators. Kernels for learning non-linear functions.

Module-4

Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies - Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. KNearest-neighbor algorithm. Case-based learning - Text Classification: Bag of words representation. Vector space model and cosine similarity. Relevance feedback and Rocchio algorithm. Versions of nearest neighbor and Naive Bayes for text.

Module-5

Clustering and Unsupervised Learning: Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. K-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabled data - Language Learning: Classification problems in language: word-sense disambiguation, sequence labeling. Hidden Markov models (HMM's). Veterbi algorithm for determining most-probable state sequences. Forward-backward EM algorithm for training the parameters of HMM's. Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Conditional random fields (CRF's). Probabilistic context-free grammars (PCFG). Parsing and learning with PCFGs. Lexicalized PCFGs.

Course outcomes:

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

CO1. Choose the learning techniques with this basic knowledge

CO2. Apply effectively genetic algorithms for appropriate applications.

CO3. Apply bayesian techniques and derive effectively learning rules.

CO4. Choose and differentiate Clustering & Unsupervised Learning and Language Learning

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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.

Reference Books

1. Ethem Alpaydin, "Introduction to machine learning", PHI learning, 2008.
2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning", Springer 2001.
3. 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.

COMPUTER APPLICATION IN DESIGN			
Course Code	20CAE14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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,

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.

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.

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.

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.

Course outcomes:

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

CO1. Develop expertise in generation of various curves, surfaces and volumes used in geometric modelling systems.

CO2. Design, implements, and evaluates a computer-based system, process, component, or program to meet desired needs.

CO3. Analyze a problem, and identify and define the computing requirements appropriate to its solution.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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
4. Mastering CAD/CAM, Ibrahim Zeid, 2nd Ed., TMH Publishing Company Limited., New Delhi, ISBN 0-07-0634334-3

ADVANCED FINITE ELEMENT METHODS			
Course Code	20CAE15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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.

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

Module-3

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

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

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

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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.

Reference Books

1 Bathe K.J. Finite Element Procedures. Prentice Hall, 2006.

2 S.S.Rao, Finite element method in Engineering, Butterworth Heinemann,2011

3 J.N.Reddy, An introduction to nonlinear finite element analysis, Oxford University Press,2013

COMPUTER AIDED ENGINEERING LABORATORY -1			
Course Code	20CAEL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Note:
These are independent laboratory exercises.
Student must submit a comprehensive report on the problems solved and give a presentation on the same for Internal Evaluation.
Any one of the experiments done from the following list has to be set in the examination for conduction and evaluation.

Experiment #1Experimental and Numerical Analysis of Tensile Test
Part A: Experimental study of Tensile Test
Part B: Numerical Analysis of Tensile Test.

Experiment #2 Experimental and Numerical Analysis of Flexural Test
Part A: Experimental study of Flexural Test
Part B: Numerical Analysis of Flexural Test

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

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.

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.

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.

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 on contact stress.
Part B: Numerical Analysis using any FEA package.
Part C: 2D Photo Elastic Investigation.

Experiment #8 Vibration Characteristics of a Spring Mass Damper System.
Part A: Analytical Solutions.
Part B: MATLAB Simulation. Part C: Correlation Studies.

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

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. ■

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. ■

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 Technics, 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. ■

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 of Hypothesis.

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

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. ■

Course outcomes:

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

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

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.

(3) 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, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END OF I SEMESTER ***

ADVANCED CAD			
Course Code	20CAE21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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.

Module-2

Geometric Modeling: Classification of wireframe entities, Curve 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.

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.

Module-4

Solid Modelling: Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling

Module-5

Transformations: 2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering.
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).

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

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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.■

Textbook/ Textbooks

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

Reference Books

1. CAD/CAM /Groover M.P./ Pearson education
2. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
3. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson
4. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.

COMPUTATIONAL AND EXPERIMENTAL VIBRATION ANALYSIS AND CONTROL			
Course Code	20CAE22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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

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.

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

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

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

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

- Develop comprehensive knowledge in the fundamental mathematical and physical basis of finite element methods.
- Know how to build FEM models of physical problems exposed to vibration and apply appropriate constraints and boundary conditions.
- 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.
- Connect the disciplines of vibration and control on a firm mathematical basis, and study vibration control problems using MATLAB software.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

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

COMPUTATIONAL FLUID DYNAMICS			
Course Code	20CAE23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods Governing equations of fluid dynamics: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching

Module-2

Mathematical behavior of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations. Basic aspects of discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points. Grids with appropriate transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids

Module-3

Parabolic partial differential equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization. Stability analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, artificial dissipation and dispersion.

Module-4

Elliptic equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, a Gauss Siedel iteration method, point- and line-successive over-relaxation methods, and alternative direction implicit methods. Hyperbolic equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order tvd schemes.

Module-5

Scalar representation of navier-stokes equations: Equations of fluid motion, numerical algorithms: FTCS explicit, FTBCS explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, BTCS and BTBCs implicit algorithms, applications. Grid generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation. Finite volume method for unstructured grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements Numerical solution of quasi one-dimensional nozzle flow: Subsonic-Supersonic isentropic flow, Governing equations for Quasi 1-D flow, Non-dimensionalizing the equations, MacCormack technique of discretization, Stability condition, Boundary conditions, Solution for shock flows

Course outcomes:

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

CO1. To derive the stepwise procedure to completely solve a fluid dynamics problem using computational methods.

CO2. To explain the governing equations and understand the behavior of the equations.

CO3. To determine the consistency, stability and convergence of various discretization schemes for parabolic, elliptic and hyperbolic partial differential equations.

CO4. To verify variations of SIMPLE schemes for incompressible flows and Variations of Flux Splitting algorithms for Compressible flows.

CO5. To identify various methods of grid generation techniques and application of finite difference and finite volume methods to various thermal problems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbooks / Reference Books

1. Numerical Heat Transfer and Fluid Flow - S.V. Patankar, Hemisphere Publishing Company.
2. Computational Fluid Dynamics - T.J. Chung, Cambridge University Press 2003
3. Computational fluid flow and heat transfer - K. Murlidhar and T. Sounderrajan, Narosa Publishing Co.
4. Computational fluid mechanics and heat transfer - D. A. Anderson, J. C. Tannehill, R.H. Pletcher, Tata McGraw-Hill Publications 2002
5. Computational fluid dynamics - J.A. Anderson, McGraw-Hill Publications 1995

An Introduction to Computational Fluid DynamicsVersteeg, H.K. and Malalasekara, W., , Pearson Education, 2010.

CIM & ROBOTICS for AUTOMATION			
Course Code	20CAE241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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.

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.

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.

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.

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.

Course outcomes:

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

1. To impart the basic concepts in manufacturing systems and fundamentals of NC & CNC system
2. Enhance knowledge in design consideration and increasing productivity with NC machine tools, machining centers and tooling for CNC machines
3. To Understand the robotic system, available tools and technique for kinematics and its applications to industry

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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.■

Textbooks/

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, , Springer, 2008.
6. 13."Robotics for Engineers", YoramKoren, McGraw Hill International, 1985.
7. 14."Industrial Robotics",Groover, Weiss, Nagel, McGrawHill International, 1986.
8. 15."Robot Technology Fundaments"- Keramas, Thomson Vikas Publication House, 1999.

COMPOSITE MATERIALS TECHNOLOGY			
Course Code	20CAE242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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.

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.

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)

Module-4

Analysis of Composite Structures: Optimization of Laminates, composite laminates of uniform strength, application of optimal compositestructures, 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.

Module-5

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

Course outcomes:

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

- Understand the use of fibre -reinforced composites in structural applications.
- 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.
- Apply the basic micro-mechanics theories in the design of fibre reinforced composites.
- Analyze the performance of composites in engineering applications.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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.

Reference Books

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

VEHICLE AERODYNAMICS			
Course Code	20CAE243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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.

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.

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.

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

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

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

Theory and Applications of Aerodynamics for Ground Vehicles- T. Yomi Obidi. Published by SAE, 2014, ISBN 978-0-7680-2111-0.

Reference Books
1 . Competition Car Aerodynamics, A Practical Hand Book, 3rd Edition, Simon McBeath, Willem Toet, Published by Veloce Publishing, 2015 ISBN 978-1845847760. 2 . Aerodynamics of Road Vehicles, W.H.Hucho, Published by SAE International, 2015. 3 . Low Speed Wind Tunnel Testing, 3rd Edition, Jewel B. Barlow, William H. Rae Jr., Alan Pope, Wiley India Pvt Ltd, 2010

OPTIMIZATION METHODS			
Course Code	20CAE251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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.

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.

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.

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 principle-Genetic operators-Numerical problem-Simulated Annealing – Numerical problem - Neural network based optimization-Optimization of fuzzy systems-fuzzy set theory-computational procedure.

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.

Course outcomes:

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

- Upon completion of this course, the student shall be able to:
- Formulate the design problem in mathematical form which can be solved by suitable optimization algorithm.
- Solve the design problem which involves non-linear constraints.
- Compare the efficiency of different algorithms.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

1. Singiresu S. Rao, Engineering Optimization - Theory and Practice, John Wiley & Sons, Inc., 2009

Reference Books

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

APPLIED MATERIALS ENGINEERING			
Course Code	20CAE252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

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

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

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

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

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.

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

(1) George E. Dieter, Mechanical Metallurgy, Mc Graw Hill, 2013.

Reference Books

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

DESIGN OF MICRO ELECTRO MECHANICAL SYSTEMS			
Course Code	20CAE253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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

Module-2

Microfabrication 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

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.

Module-4

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

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.

Course outcomes:

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

CO1. Students will be in a position to demonstrate their knowledge in micro machining and micro electromechanical systems.

CO2. Students will come to know about application of memes in manufacturing sector.

CO3. Will acquire the knowledge about working of different memes devices.

CO4. Students will come to know characteristics of different memes devices and its application

CO5. Develop new ideas and applications for MEMS devices.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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.

ReferenceBooks

1. M.H. Bao, “Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes” Handbook, Elsevier.
2. NadimMaluf, An Introduction to Microelectromechanical Systems Engineering, Artech House Publishers, 2000.
3. Stephen D. Senturia, "Microsystems Design" Kluwer Academic Publishers, New York.

COMPUTER AIDED ENGINEERING LABORATORY -II			
Course Code	20CAEL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

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 recovery of elastic strains. Goal: Become familiar with input and postprocessing 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 based constraint to a structure. Goal: Apply a translational and rotational displacement load to a structure and simulate both a rigid and flexible response (similar to CERIG and RBE3 type behaviours)
Note: The above analysis can be performed by using any FEA/CAE packages	

TECHNICAL SEMINAR			
Course Code	20CAE27	CIE Marks	100
Number of contact Hours/week (L:P:SDA)	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic 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.

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

Marks distribution for CIE of the course 20XXX27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END OF II SEMESTER***

ADVANCED MACHINE DESIGN			
Course Code	20CAE31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

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.

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 surfacefinish, Life estimation by ε-N approach.

Module-3

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

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, LifeEstimation using stress life approach, Numerical examples.
Notch strain analysis: Strain– life approach, Neuber' s rule, Glinka' s rule, applications of Fracture mechanics to crack growth at notches, Numerical examples.

Module-5

SurfaceFailure:Introduction,Surfacegeometry,Matingsurface,Friction,Abrasivewear,Corrosionwear.
Surface fatigue: spherical contact, Cylindrical contact, General contact, Dynamic contactstresses, Surfacefatiguestrength, Surface fatigue failure modes, Design to avoid Surface failures.

Course outcomes:

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

- CO1. Apply state of the art design methodology namely design by analysis and damage tolerant design to mechanical components.
- CO2. Distinguish different design criteria and their procedure to carry out the design of mechanical components.
- CO3. Design machine components which are subjected to fluctuating loads.
- CO4. Design machine components using techniques like stress life approach, Strain life approach and Fracture mechanics approach.
- CO5. Define the various statistical aspects of fatigue using different probability distribution plots.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

1. RalphI. Stephens,AliFatemi, Robert, Henryo. Fuchs, " Metal Fatigue in engineering" , John Wiley New York, 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.

Reference Books

1. S.Suresh , " Fatigue of Materials" , Cambridge University Press, -1998
2. Julie.A.Benantine, " Fundamentals of Metal Fatigue Analysis" , PrenticeHall,1990
3. Fatigue and Fracture, ASM Hand Book, Vol .19,2002.

MECHATRONICS SYSTEM DESIGN			
Course Code	20CAE321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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.

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.

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.

Module-4

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

Module-5

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

Course outcomes:

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

CO1. Describe mechatronic systems and overview of control systems & actuators.
CO2. Identify and describe the different types of actuators used in mechatronic systems.
CO3. Differentiate between various sensors, transducers and actuators and their applications.
CO4. Identify and describe the different types of speed- and position feedback devices.
CO5. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers.
CO6. Discuss the importance of feedback in controlling physical systems with the use of examples.
CO7. Explain the principle of operation of ac induction motor, dc motor, servomotor and stepper motor.
CO8. Identify and describe the types of controllers used in mechatronic systems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

(1) W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999 2. HSU “MEMS and Microsystems design and manufacture” - Tata McGraw-Hill Education, 2002

Reference Books

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics” - IEEE Press, 1 Edition, 1996
2. Shetty and Kolk “Mechatronics System Design” - Cengage Learning, 2010
3. Mahalik “Mechatronics” - Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics” - Tata McGraw-Hill Education, 1998
5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”– . Mc Grew Hill, 2002
6. “Fine Mechanics and Precision Instruments” - Pergamon Press, 1971.

NANOSCALE MODELING AND SIMULATION			
Course Code	20CAE322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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.

Module-2

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

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.

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.

Module-5

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

Course outcomes:

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

CO1. Differentiate between simulation and modelling of nano materials
CO2. Apply knowledge of various concepts related to nano sized materials
CO3. Implementation of Monte Caro algorithms for Nano materials.
CO4. Calculate the interatomic potential for Nano materials.
CO5. Analyse nano material using different modelling software.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

TextbookS/ Reference 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

COMPUTER AIDED MANUFACTURING			
Course Code	20CAE323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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

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.

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.

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.

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.

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

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

1. Computer Control of Manufacturing Systems / Yoram Koren / McGraw Hill. 1983.
2. Computer Aided Design Manufacturing – K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, PHI, 2008.
3. CAD/CAM Principles and Applications, P.N. Rao, TMH. 4. Alavala, CAD/CAM PHI.

Reference Books

1. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age
2. Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson
3. Computer Numerical Control Concepts and programming, Warren S Seames, Thomson

DYNAMICS AND MECHANISM DESIGN			
Course Code	20CAE331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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.

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.

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.

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.

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.

Course outcomes:

At the end of the course the student will be able to:
CO1. Apply the tools of analytical dynamics with the main goal of developing mathematical models that describe the dynamics of systems of rigid bodies.
CO2. Formulate equations of motion for complicated mechanical systems /linkages and hods for solving these equations.
CO3.Understand multi body dynamics in mechanical engineering design

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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.

Reference Books

1. J E Shigley, “Theory of Machines and Mechanism” -McGraw-Hill, 1995
2. A.G.Ambekar , “Mechanism and Machine Theory”, PHI, 2007.
3. Ghosh and Mallick , “Theory of Mechanism and Mechanism”, East West press

SMART MATERIALS AND STRUCTURES			
Course Code	20CAE332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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.

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.

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.

Module-4

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

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 MEMS applications.

Course outcomes:

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

CO1. Understand the behavior and applicability of various smart materials.

CO2. Design simple models for smart structures & materials.

CO3. Devise experiments to verify the predictions.

CO4. Judge the appropriate application of smart materials with respect to the feasibility of their fabrication and implementation, and to the economic aspects.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

1. Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, ArtechHouse, Boston, 1996 (ISBN : 0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267

Reference Books

1. Electro ceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin;New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. ShapeMemoryMaterials-K.OtsukaandC.M.Wayman,CambridgeUniversityPress, Cambridge; NewYork, 199~ (ISBN:052144487X).

DESIGN OF VIBRATION CONTROL SYSTEMS			
Course Code	20CAE333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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.

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.

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.

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.

Module-5

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

Course outcomes:

At the end of the course the student will be able to:
CO1. 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.
CO2. Model single-and multi-degree of freedom for free and forced vibrations and determine response to vibration, natural frequencies and modes of vibration.
CO3. Apply the fundamentals of vibration to its measurement and analysis.
CO4. Solve realistic vibration problems in mechanical engineering design that involves application of most of the course syllabus.
CO5. Ability to design and develop vibrations and noise control systems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have 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. ■

Textbook/ Textbooks

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

Reference Books

1. S. Graham Kelly," Mechanical Vibrations" , Schaum' s Outlines, TataMcGraw Hill, 2007.
2. C Sujatha," Vibrations and Acoustics – Measurements and signalanalysis" , Tata McGraw Hill, 2010

PROJECT WORK PHASE – 1			
Course Code	20CAE34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- 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.

MINI PROJECT			
Course Code	20CAE35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- 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.

Mini-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 avoiding plagiarism.

Course outcomes:

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

- Present the mini-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 Mini - Project:

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

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20CAEI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course 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,

To put theory into practice.

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.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

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 the activities 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.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 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 (30 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 appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	20CAE41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- 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: 20 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: 10 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: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 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 appointed by the University. ■