RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R. V. Vidyaniketan Post, Mysuru Road

Bengaluru – 560 059

Scheme and Syllabus of I & II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

MACHINE DESIGN

DEPARTMENT OF

MECHANICAL ENGINEERING

INNER FRONT COVER PAGE

College Vision & Mission
(To be included from our side)

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MACHINE DESIGN

DEPARTMENT OF

MECHANICAL ENGINEERING

VISION

Quality education in Design, Materials, Thermal and Manufacturing with emphasis on research, sustainable technologies and entrepreneurship for societal symbiosis.

MISSION

- Imparting knowledge in basic and applied areas of Mechanical Engineering.
- Providing state-of-the-art laboratories and infrastructure for academics and research in the areas of design, materials, thermal engineering and manufacturing.
- Facilitating faculty development through continuous improvement programs.
- Promoting research, education and training in materials, design, manufacturing, Thermal Engineering and other multidisciplinary areas.
- Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
- Imbibing social and ethical values in students, staff and faculty through personality development programs

Program Outcomes (PO)

M. Tech. in Machine Design graduates will be able to:

PO1: An ability to independently carry out a research / investigation and development work to solve practical problems related to machine design.

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

PO3: An ability to demonstrate a degree of mastery over the areas of machine design. The mastery should be at a level higher than the requirements in the BE Mechanical Engineering and allied programs

PO4: An ability to use modern tools for the design and analysis of static and dynamic systems and mechanisms

PO5: An ability to adapt technical, safety, ethical and environmental factors in the design of system and mechanism

PO6: An ability to perform in multidisciplinary teams with sound interpersonal and management skills with a commitment to lifelong learning

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PHY	Physics
21.	CHY	Chemistry
22.	MAT	Mathematics

INDEX

RV COLLEGE OF ENGINEERNG®, BENGALURU-560 059
(Autonomous Institution Affiliated to VTU, Belagavi)
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech in Computer Integrated Manufacturing

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MAT11A	Applied Mathematics	MAT	4	0	0	**4**
2	18MMD12	Mechanics of Composite Materials	ME	4	0	1	**5**
3	18MMD13	Kinematics and Dynamics of Mechanisms	ME	4	0	1	**5**
4	18HSS14	Professional Skills Development	HSS	0	0	0	**0**
5	18XXX 1AX	Elective A	ME	3	1	0	**4**
6	18XXX1BX	Elective B	ME/CSE	4	0	0	**4**
Total number of Credits				**19**	**01**	**02**	**22**
Total Number of Hours / Week							

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MMD21	Advanced Solid Mechanics	ME	4	0	1	**5**
2	18MMD22	Advance Theory of Vibrations	ME	3	1	0	**4**
3	18IM23	Research Methodology	IEM	3	0	0	**3**
4	18MMD24	Minor Project	ME	0	0	2	**2**
5	18XXX2CX	Elective C	ME	4	0	0	**4**
6	18XXX2DX	Elective D	ME	4	0	0	**4**
7	18XXX2GXX	Global Elective	Respective Boards	3	0	0	**3**
Total number of Credits				**21**	**01**	**03**	**25**
Total Number of Hours / Week							

I Semester		
GROUP A: CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18 MPD1A1	Product Design for Quality
2.	18 MMD1A2	Tribology
3.	18 MCM1A3	Design of Hydraulic & Pneumatic Systems
GROUP B: CORE ELECTIVES		
1.	18 MPD1B1	Product Data Management
2.	18MCE1B2	Intelligent Systems
3.	18 MCM1B3	Non-Traditional Machining & Testing
II Semester		
GROUP C: CORE ELECTIVES		
1.	18MMD2C1	Theory of Plates and Shells
2.	18MPD2C2	Design for Manufacture and Assembly
3.	18MCM2C3	Computer Application in Design
GROUP D: CORE ELECTIVES		
1.	18MMD2D1	Advanced Machine Design
2.	18MCM2D2	Robotics and Automation
3.	18MMD2D3	Advanced Finite Element Analysis

GROUP E: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	CS	18CS2G01	Business Analytics	3
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	3
3.	IM	18IM2G03	Modelling using Linear Programming	3
4.	IM	18IM2G04	Project Management	3
5.	CH	18CH2G05	Energy Management	3
6.	ME	18ME2G06	Industry 4.0	3
7.	ME	18ME2G07	Advanced Materials	3
8.	CHY	18CHY2G08	Composite Materials Science and Engineering	3
9.	PHY	18PHY2G09	Physics of Materials	3
10.	MAT	18MAT2G10	Advanced Statistical Methods	3

Semester: I						
APPLIED MATHEMATICS (Common to MPD,MMD,MCM,MPE,MBT,MBI,MCH,MST,MHT)						
Course Code	**:**	**18MAT11A**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
STATISTICS Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation.	
Unit – II	**10 Hrs**
PROBABILITY DISTRIBUTIONS Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.	
Unit – III	**10 Hrs**
SYSTEM OF LINEAR EQUATIONS AND EIGEN VALUE PROBLEMS System of linear equations-LU decomposition and Gauss-Jordan method, Eigen value problems–bounds on eigen values, Power method and Inverse Power method, Eigen values and eigen vectors of real symmetric matrices-Jacobi method.	
Unit – IV	**11 Hrs**
NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS Boundary value problems (BVP's)–finite difference method for linear and nonlinear problems, Shooting method and Galerkin method. Finite differences-implicit and explicit scheme, Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations, Finite element method and simple problems.	
Unit – V	**11 Hrs**
CONCEPTS OF ENGINEERING OPTIMIZATION Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various field engineering.

CO2: Apply the knowledge and skills of statistical/numerical/optimization techniques to solve problems of least squares, probability distributions, linear equations, eigen value problems and differential equations.

CO3: Analyze the physical problem to establish a statistical / mathematical model and use an appropriate method to solve and optimize the solution.

CO4: Distinguish the overall mathematical knowledge gained to demonstrate the problems of least squares, probability distributions, linear equations, eigen value problems, differential equations and optimization arising in practical situations.

	Reference Books:
1	Theory and Problems of probability, Seymour Lipschutz and Marc lars Lipson,Schaum's Outline Series, 2nd edition, ISBN: 0-07-118356-6.
2	Introductory method of numerical analysis, S. S. Sastry, Prentice-Hall India Pvt. Ltd. 4th edition, 2009, ISBN : 81-203-1266-X.
3	Numerical methods for scientific and engineering computation, M K Jain, S. R. K. Iyengar, R. K. Jain, New Age International Publishers, 6th edition; 2012, ISBN-13:978-81-224-2001-2.
4	Engineering Optimization Theory and Practice, Singiresu S. Rao, 3rd edition, New Age International (P)Ltd., ISBN: 81-224-1149-5.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: I						
MECHANICS OF COMPOSITE MATERIALS (Theory & Practice)						
Course Code	**:**	**18MMD12**		**CIE Marks**	**:**	**100 + 50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100 + 50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
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 for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems.Invariant properties.Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.	
Unit – II	**11 Hrs**
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 tensor theory, Numerical problem, practical recommendations.	
Unit – III	**11 Hrs**
Macro Mechanical Analysis of Laminate: Introduction, code, Kirchoff 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)	
Unit – IV	**10 Hrs**
Analysis of Composite Structures: Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures	
Unit – V	**10 Hrs**
Manufacturing and Testing: lay-up and curing - open and closed mold processing, Hand lay-up techniques, Bag molding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method. **Applications:** Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.	
Unit –VI Composites Lab	**26 Hrs**
1. Identify the different ASTM Standards used for characterization of advanced materials. 2. Synthesis of thermosetting and thermoplastic composites 3. Conduct the physical and mechanical properties of the advanced engineering materials 4. Manufacturing and testing of Nano-composite 5. Ageing hardening of Al alloy	

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the manufacturing process involved thermoplastic, thermoset and ceramic materials

CO2: Apply rule of mixtures to evaluate mechanical properties of composites

CO3: Describe Manufacturing and testing of composites

CO4: Evaluate the design considerations based on material & process

Reference Books:	
1	Mechanics of Composite materials, Autar K. Kaw, CRC Press, 2nd Ed, 2005. ISBN 0-8493-1343-0
2	Mechanics of Laminated Composite Plates & Shells, J. N. Reddy, CRD Press, 2nd Ed, 2004, ISBN 9780849315923
3	Composite Materials handbook, Mein Schwartz, McGraw Hill, 1984, I SBN 10: 0070557438/ ISBN 13: 9780070557437
4	Mechanics of Composite Materials, Rober M. Jones,Taylor & Francis, 1998. ISBN 1-56032-712-X

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

Semester: I						
KINEMATICS AND DYNAMICS OF MECHANISMS (Theory & Practice)						
Course Code	**:**	**18MMD13**		**CIE Marks**	**:**	**100 + 50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100 + 50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
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: Development of different mechanisms and its inversions like four bar chain mechanism, slider crank mechanism, double slider cranks, mechanism.	
Unit – II	**11 Hrs**
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, Hamilton's equations, Hamilton's principle, Lagrange's, equation from Hamilton's principle, Derivation of Hamilton's equations, Examples.	
Unit – III	**11 Hrs**
Analytical Methods of Dimensional Synthesis: 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	
Unit – IV	**10 Hrs**
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 32 Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.	
Unit –V	**10 Hrs**
Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.	
Unit –VI Kinematics and Dynamics of Mechanisms Lab	**26 Hrs**
Modeling and functional simulation of: 1. Freely falling body 2: Inclined Plane 3: Lift Mechanism - Geometry 4: Lift Mechanism - Simulation 5: One-degree-of-freedom Pendulum 6: Projectile 7: Spring Damper - Part 1 8: Spring Damper - Part 2 9: Suspension System 1 10: Suspension System 2 11: Four Bar Mechanism 12: Cam-Follower 13: Crank Slider 14: Controls Toolkit in ADAMS/View.	

Course Outcomes:
After going through this course the student will be able to:

CO1: Describe the fundamental concepts of kinematics and dynamics
CO2: Design and analyze mechanism and kinematic linkages
CO3: Identify, formulate and solve engineering dynamic problems
CO4: Determine forces acting on the parts of machines used in Industries

Reference Books:	
1	Kinematics, Dynamics and Design of Machinery, K.J.Waldron & G.L.Kinzel, Wiley India, 2007. ISBN-10: 0471244171
2	Classical Dynamics, Greenwood, Prentice Hall of India, 1988. *ISBN*-13: 978-0486696904
3	Theory of Machines and Mechanism, J E Shigley, McGraw-Hill, 1995, *ISBN:*12-0471344276
4	Mechanism and Machine Theory, A. G. Ambekar, PHI,2007. *ISBN*: 978-81-203-3134-1

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

Semester: I						
PROFESSIONAL SKILL DEVELOPMENT (Common to all Programs)						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits L: T: P	**:**	**0:0:0**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**24 L**				

Unit – I	**03 Hrs**
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. **Resume Writing:** Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
Unit – II	**08 Hrs**
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. **Reasoning** – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification. **Analytical Reasoning** - Single & Multiple comparisons, Linear Sequencing. **Logical Aptitude** - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. **Verbal Analogies/Aptitude** – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving	
Unit – III	**03 Hrs**
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews	
Unit – IV	**03 Hrs**
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion (Assertiveness) and presentation skills	
Unit – V	**07 Hrs**
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). **Leadership Skills:** Ethics and Integrity, Goal Setting, leadership ability.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Develop professional skill to suit the industry requirement.

CO2: Analyze problems using quantitative and reasoning skills

CO3: Develop leadership and interpersonal working skills.

CO4: Demonstrate verbal communication skills with appropriate body language.

Reference Books:	
1.	The 7 Habits of Highly Effective People, Stephen R Covey, 2004 Edition, Free Press, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie, 1st Edition, 2016, General Press, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book, 2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE)
Evaluation of CIE will be carried out in TWO Phases.

Phase	**Activity**
I	After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
FINAL CIE COMPUTATION	
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.	

Semester: I						
PRODUCT DESIGN FOR QUALITY (Group A: Core Elective)						
Course Code	**:**	**18MPD1A1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Design for quality : Taguchi's Approach to Quality, On-line and Off-line Quality Control, , Quality Loss Function, System Design, Parameter Design, Design for Environment, Human factor design, Design for casting and forging , Causes of Variation.	
Unit – II	**08 Hrs**
Quality Function Deployment –Introduction, QFD team, benefits, voice of customer, organisation of information, house of quality, QFD process **Design of Experiments**: Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design	
Unit – III	**08 Hrs**
Failure Mode Effect Analysis: Refining geometry and layout, Failure tree analysis, Defects and failure modes Techniques of failure analysis, Filed inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.	
Unit – IV	**08 Hrs**
Statistical Consideration in Product Design and Development Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution- Statistical Process control–Scatter diagrams – Multivariable charts	
Unit –V	**08 Hrs**
Six Sigma – Overview, Basics and history of the approach for six sigma, Methodology and focus, the application of Six Sigma in production and in service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy	

Course Outcomes:
After going through this course the student will be able to:

CO1: Identify the importance of various principles of quality in product or service
CO2: Use statistical tools in product development
CO3: Apply basic risk analysis and experiment design techniques into practical cases
CO4: Demonstrate knowledge about Six sigma, Design of Experiments

Reference Books:	
1	Total quality Management Kevin Otto & Kristin Wood, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE), 2001. ISBN10: 0130212717
2	Product Design and Development, Karl T. Ulrich, Steven D. Eppinger, TATA McGraw - HILL - 3rd Edition, 2003. ISBN:13: 978-0073404776
3	The Management and control of Quality, James R. Evens, William M Lindsay,6th edition- South-Western Publishers ISBN: 0314062157
4	Engineering Design, George E Dieter, 3rd Edition, McGraw hill International Edition, ISBN: 0-07-116204-6

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: I						
TRIBOLOGY (Group A: Core Elective)						
Course Code	**:**	**18MMD1A2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems	
Unit – II	**08 Hrs**
Hydrodynamic Lubrications: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems. **Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Somerfield number and its significance, partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.	
Unit – III	**08 Hrs**
Hydrostatic Bearings: Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.	
Unit – IV	**08 Hrs**
EHL Contacts: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution. **Porous Bearings:** Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages.	
Unit –V	**08 Hrs**
Magnetic Bearings: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings	

Course Outcomes:

After going through this course the student will be able to:

CO1: Demonstrate fundamentals of tribology, lubricants and methods of lubrication

CO2: Analyze bearings for load carrying capacity, frictional force and power loss

CO3: Illustrate the different modes of lubrication system for various applications.

CO4: Design the different bearing system such as antifriction bearings, magnetic bearings and porous bearings for various applications

	Reference Books:
1	Theory and practice of Lubrication for Engineers, Dudley D.Fuller, New YorkCompany.1998
2	Principles and applications of Tribology, Moore, Pergamon press, 1975
3	Engineering Tribology, G W Stachowiak, A W Batchelor, Elsevier publication 1993.
4	Lubrication of Bearings - Theoretical principles and design, Radzimovsky, Oxford press Company, 2000

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: I						
DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS (Group A: Core Elective)						
Course Code	**:**	**18MCM1A3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction to Hydraulic System: Introduction, Basic hydraulic system, classification of hydraulic motors, hydraulic pumps, Performance of hydraulic motors, Hydraulic actuators, types of hydraulic actuators. **Control Components in Hydraulic Systems:** Introduction, Direction control valves, Solenoid actuated valve, Pilot operated valve, Rotary spool DCV, Pressure control valves, Hydraulic fuse, Flow control valve, graphic symbols.	
Unit – II	**08 Hrs**
Maintenance of Hydraulic Systems: Prime function of hydraulic fluids, desirable properties of hydraulic fluids, general types of fluids, factors affecting the selection of fluids, sealing devices, reservoir systems, filters and strainers, heat exchangers, pressure switch, wear of moving parts, troubleshooting of hydraulic systems.	
Unit – III	**08 Hrs**
Hydraulic circuit Design and Analysis: Control of a single acting cylinder, double acting cylinder, regenerative circuit, counter balance valve applications, Hydraulic cylinder sequencing circuits, automatic cylinder reciprocating systems, Locked cylinder using pilot check valves, cylinder synchronizing circuits, fail safe circuits.	
Unit – IV	**08 Hrs**
Pneumatic Concepts: Introduction, comparison of hydraulics/pneumatics/and electrical system, air compressor system, types of compressors, compressed air behavior, pneumatic actuators, direction control valves, building a pneumatic circuits, application of logic valves. **Design of Pneumatic Circuits:** Speed control circuits, Application of time delay valves. Position sensing in pneumatic cylinders, roller lever valve, pressure sensing in pneumatic circuits, pressure sequence valve, two cylinder movement,cascade method.	
Unit –V	**08 Hrs**
Electro-Pneumatics: Introduction, Pilot operated solenoid valve, Electrical connection to the solenoid, Electro-pneumatic circuit, Electrical limit switches and proximity switches, Relays, Solenoid, PE converter, Concept of latching. **Servo System and PLC Applications in Pneumatics**: Closed loop control with servo system, Hydro-mechanical servo system, Electro-hydraulic servo system, Conventional valve vs proportional valve, Proportional valve in hydraulic circuits, characteristics of proportional valve and servo valve. PLC application in fluid power, logic in ladder logic diagram and Mnemonics, Timer- on delay and off delay.	

Course Outcomes:
After going through this course the student will be able to:

CO1: Describe the constructional features of hydraulic and pneumatic components

CO2: Apply hydraulic and pneumatic controls in the design of automated controls.

CO3: Evaluate the design of hydraulic and pneumatic components for building a circuit

CO4: Design the hydraulic and pneumatic based systems for industrial applications.

	Reference Books:
1	Introduction to Hydraulics and Pneumatics, S Ilango, V Soundararajan, PHI Publication, ISBN-978-81-203-3079-5.
2	Hydraulics and Pneumatics, Jagadeesha T, I K International Publication, ISBN: 978-93-84588-90-8
3	Introduction to fluid power, James L Johnson, Cengage Learning, First Edition 2003, ISBN- 981-243-661-8
4	Hydraulic and pneumatic controls, R Srinivasan, Tata McGraw hill, second edition,2010 ISBN – 978-81-8209-138-2

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: I						
PRODUCT DATA MANAGEMENT (Group B: Core Elective)						
Course Code	**:**	**18MPD1B1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Centralized systems: Client Server Systems, Parallel Systems, Distributed Systems, Network Types, Parallel Database, Distributed Database, Security and Integrity, Standardization views. Product Data Management: Complexity in Product Development, General Description of PDM Basic functionality of PDM: Information architecture, PDM System architecture, Applications used in PDM systems. Trends in PDM	
Unit – II	**11 Hrs**
Product life cycle management – Need for PLM, Components of PLM, Product Data and Product workflow, Drivers for Change, The PLM Strategy, Developing a PLM Strategy, A Five-step Process	
Unit – III	**11 Hrs**
Document Management Systems: Document management and PDM, Document life cycle, Content Management, Document management and related technologies, Document management resources on the Internet Workflow Management in PDM: Structure Management, Engineering Change Management, Release Management, Version Management, Configuration Management	
Unit – IV	**10 Hrs**
Creating Product Structures: Part centric approach, CAD centric approach, Product Structure configuration, Managing Product Structures, PDM resources on the Internet.	
Unit –V	**10 Hrs**
PDM Implementation Case Studies: Matrix One, Team Center, Windchill, Enovia. Standards in PDM, CM, SCM and CMM.	

Course Outcomes:
After going through this course the student will be able to:

CO1: Understanding the Product data base systems

CO2: Select the Product data base systems based on material and product

CO3: Analyzing the Product data base and Product life cycle for new products

CO4: Evaluate the parameters for Product data base considerations based on process

Reference Books:	
1	Implementing and Integrating Product Data Management and Software Configuration Management - 20 - Ivica Cmkovic Ulf Asklund - Annita Persson Dahlqvist - Archtech House Publishers.
2	Product Data Management - Rodger Burden - Publisher: Resource Publishing- ISBN-10: 0970035225, ISBN-13: 978-0970035226 – 2003.
3	Windchill 8.0 – PDM Link User's Guide- Parametric Technology Corporation (PTC),2008
4	The AutoCAD Database Book – Accessing and Managing CAD Drawing Information - Galgotia Publications - Third Edition.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: I						
INTELLIGENT SYSTEMS **(Group B: Core Elective)** **(Common to CSE, MPD, MMD, CIM)**						
Course Code	**:**	**18MCE1B2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11 Hrs**
Overview of Artificial Intelligence: Artificial Intelligence and its Application areas; **Knowledge Representation and Search:** The Predicate Calculus: The Propositional Calculus, The Predicate Calculus, Using Inference Rules to Produce Predicate Calculus Expressions, Application: A Logic-Based Financial Advisor; **Structures and strategies for state space search:** Introduction, Structures for state space search ,Strategies for State Space Search, Using the State Space to Represent Reasoning with the Predicate Calculus; And/or Graphs.	
Unit – II	**10 Hrs**
Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, The Best-First Search Algorithm, Admissibility, Monotonicity and Informedness, Using Heuristics in Games, Complexity Issues. **Control and Implementation of State Space Search**: Introduction, Recursion-Based Search, Production Systems, The Blackboard Architecture for Problem Solving.	
Unit – III	**10 Hrs**
Other Knowledge Representation Techniques: Semantic Networks, Conceptual Dependencies, Scripts and Frames, Conceptual Graphs. **Knowledge Intensive Problem Solving:** Overview of Expert System Technology, Rule-Based Expert Systems, Model-Based, Case Based, and Hybrid Systems **Planning:** Introduction to Planning, Algorithms as State-Space Search, Planning graphs.	
Unit – IV	**10 Hrs**
Automated Reasoning: Introduction to Weak Methods in Theorem Proving, The General Problem Solver and Difference Tables, Resolution Theorem Proving; **Uncertain Knowledge and Reasoning:** Introduction to Uncertainty, Inference using Full-Joint Distribution, Independence, Bayes' Rule and its use. **Representing Knowledge in Uncertain Domain:** Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Network, Approximate Inference in Bayesian Network	
Unit –V	**11 Hrs**
Introduction to Learning: Forms of Learning: Supervised learning, Unsupervised Learning, Semi-Supervised and Reinforcement Learning; Parametric Models & Non-Parametric Models, Classification and Regression problems **Artificial Neural Networks:** ANN Structures, Single Layer feed-forward neural networks, Multi-Layer feed-forward neural networks, Learning in multilayer networks, networks. **Artificial Intelligence Current Trends :** The Science of Intelligent Systems, AI: Current Challenges and Future Directions;	

Course Outcomes:
After going through this course the student will be able to:

CO1: Explore various Artificial Intelligence problem solving techniques.

CO2: Identify and describe the different AI approaches such as Knowledge representation, Search strategies, learning techniques to solve uncertain imprecise, stochastic and nondeterministic nature of AI problems.

CO3: Apply the AI techniques to solve various AI problems.

CO4: Analyse and compare the relative challenges pertaining to design of Intelligent Systems

Reference Books:	
1	Artificial Intelligence – Structures and Strategies for Complex problem Solving, George F Luger, 6th Edition, Pearson Publication, 2009, ISBN-10: 0-321-54589-3, ISBN-13: 978-0-321-54589-3
2	Artificial Intelligence A Modern Approach, Stuart Russel, Peter Norvig, 3rd Edition, Pearson Publication, 2015, ISBN-13: 978-93-325-4351-5
3	Artificial Intelligence, Elaine Rich, Kevin Knight,3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709, ISBN-13: 978-0070087705
4	Intelligent Systems-A Modern Approach, Grosan, Crina, Abraham, Ajith, Springer-Verlag Berlin Heidelberg 2011, ISBN 9783642269394, 2011.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: I						
NON-TRADITIONAL MACHINING & TESTING (Group B: Core Elective)						
Course Code	**:**	**18MCM1B3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

Introduction: Need for unconventional machining processes, classification of non-traditional machining processes.

Abrasive Jet Machining (AJM): Abrasive Jet Machining Setup – Gas propulsion System, Abrasive feeder, Machining Chamber, AJM Nozzle; Parametric Analysis – Stand-off-distance, Abrasive flow rate, Nozzle pressure, Mixing ratio; Process Capabilities.

Ultrasonic machining (USM): Ultrasonic Machining System, Mechanics of cutting, Model proposed by Shaw – Grain Throwing Model, Grain Hammering Model; Parametric Analysis, Process Capabilities.

Unit – II	**11 Hrs**

Water Jet Cutting (WJC): WJC Machine, Process Characteristics, Process Performance. Applications, Advantage and Limitations.

Abrasive Water Jet Machining (AWJM): Working Principle, AWJM Machine – Pumping System, Abrasive Feed System, Abrasive Water Jet Nozzle, Catcher; Process Analysis – Water Jet Pressure during Slotting, Water Flow Rate, Abrasive Flow Rate, Abrasive Particle Size, Abrasive Material, Cutting Parameters – Traverse Speed, Number of Passes, Stand-Off-Distance, Process Capabilities.

Abrasive Flow Machining (AFM): Working Principle of Abrasive flow Machining System Process Variables,

Magnetic Abrasive Finishing (MAF) – Working Principle of MAF, Material Removal and Surface Finish – Type and Size of Grains.

Unit – III	**11 Hrs**

LASER Beam Machining (LBM): Production of LASERS, Working Principle of LASER Beam Machining, Types of Lasers – Solid State Lasers, Gas Lasers; Process Characteristics. Applications, Advantage and Limitations.

Plasma Arc Machining (PAM): Working Principle, Plasma Arc Cutting System, Elements of Plasma Arc Cutting System, Process Performance.

Electron Beam Machining (EBM): Working Principle, Electron Beam Machining System – Electron Beam Gun, Power Supply, Vacuum System and Machining Chamber; Process Parameters, Characteristics of the Process. Applications, Advantage and Limitations.

Unit – IV	**10 Hrs**

Electrochemical Machining (ECM): Electrolysis, ECM Principle, ECM Machine Tool-Power Source, Electrolyte supply and Cleaning System, Tool and Tool Feed System, Workpiece and Work Holding Device; Theory of ECM – Faraday's Laws of Electrolysis, Electrochemical Equivalent of Alloys, Material Removal Rate in ECM.

Chemical Processes: Introduction, Maskants – Cut and Peel, Screen Printing, Photoresist Maskant; Electropolishing – Introduction, Process Description, Process parameters, Process limitations, Applications, Advantage and Limitations.

Unit –V	10 Hrs
Non Destructive Testing: Scope and advantages of NDT, comparison of NDT with DT, classifications of NDT, introduction, principle, equipment, procedures and characteristics of Visual Inspection, Eddy Current Testing, Liquid Penetrant Testing, Magnetic Particle Testing and Radiographic Testing.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the principle, mechanism of metal removal of various unconventional machining processes.

CO2: Analyses the process parameters and their effect on the component machined on various unconventional machining processes and tested using NDT techniques.

CO3: Apply the concept for different NTM and NDT concepts industry.

CO4: Evaluate appropriate NTM and non-destructive techniques.

Reference Books:	
1	Non Tradtional Machining Techniques, Bennedict, G. F., Marcel Decker, New York, 1990 ISBN 9780824773526
2	Modern Manufacturing Process, Pandey and Sha, Prentice Hall, New Delhi, 1997 ISBN: 978-81-7319-138-1
3	Unconventional Machining Process, Garry F. Benedict, Marcel Dekker Publication, New York, 1987. ISBN: 0-8247-7352-7
4	Non-Destructive Testing and Evaluation of Materials, I. J Prasad, C G K Nair, Tata McGraw Hill Education Private Limited

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SECOND SEMESTER

Semester: II						
ADVANCED SOLID MECHANICS (Theory & Practice)						
Course Code	**:**	**18MMD21**		**CIE Marks**	**:**	**100 + 50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100 + 50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction to general theory of elasticity: assumptions and applications of linear elasticity. Analysis of stress, stress tensors. State of stress at a point, principal stresses in two dimensions, Cauchy's stress principle, direction cosines, stress components on an arbitrary plane with stress transformation. Principal stresses in three dimensions, stress invariants, Equilibrium equations, octahedral stresses, Mohr's stress circle, construction of Mohr's Circle for two and three dimensional stress systems, equilibrium equations in polar coordinates for three-dimensional state of stresses.	
Unit – II	**11 Hrs**
Introduction to analysis of strain, types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains, Mohr's Circle for Strain, equations of Compatibility for Strain, strain rosettes. Stress-strain relations, the generalised Hooke's law, compatibility conditions, the transformation from Strain components to stress components. Strain energy in an elastic body, St. Venant's principle, uniqueness theorem	
Unit – III	**11 Hrs**
Theories of Failure and Energy Methods: Introduction, Theories of Failure, Use of Factor of Safety in Design, Mohr's theory of Failure, Ideally Plastic Solid, Stress space and Strain space, General nature of Yield locus, Yield Surfaces of Tresca and Von Mises, Stress- Strain relation (Plastic Flow), PrandtlReuss theory, Saint venant – Von mises equations. **Principle of Superposition,** Reciprocal Relation, Maxwell-Betti-Rayleigh Reciprocal theorem, First theorem of Castigliano, Expressions for Strain Energy, Statically indeterminate structures, Theorem of Virtual Work, Second theorem of Castigliano, Maxwell – Mohr integrals.	
Unit – IV	**10 Hrs**
Bending of Beams: Introduction, Straight beams and Asymmetrical Bending, Euler – Bernoulli hypothesis, Shear centre or Centre of Flexure, Shear stresses in thin walled open sections, Bending of curved beams, Deflection of thick curved bars.	
Unit –V	**10 Hrs**
Torsion: Introduction, Torsion of general prismatic bars – Solid sections, Torsion of Circular and Elliptical bars, Torsion of equivalent triangular bar, Torsion of rectangular bars, Membrane analogy, Torsion of thin walled tubes, Torsion of thin walled multiple cell closed sections, Multiple connected sections, Centre of twist and flexure centre	
Unit – VI Advanced Solid Mechanics Lab	**26 Hrs**
Exercises: 1. Basic Stress analysis 2. Deflection and Stress Analysis in beams 3. Nonlinear plastic Deformation and buckling Analysis 4. Two dimensional problems (Plane stress & Plane strain problems) 5. Analysis of Composite materials 6. Analysis of pressure vessels 7. Three dimensional FE analysis	

Course Outcomes:
After going through this course the student will be able to:

CO1: Identify the stress-strain relations in elastic and plastic conditions
CO2: Examine bodies subjected to three dimensional stresses for the onset of failure based on failure criteria.
CO3: Analyze deflections in beams subjected to different types of loads for elastic, elastoplastic and plastic conditions
CO4: Evaluate stresses in bars subjected to torsion for elastic, elastoplastic and plastic conditions

Reference Books:	
1	Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2000, ISBN-13: 978-0070702608, 2009
2	Theory of Elasticity, S. P. Timoshenko, Mc. Graw Hill, 3rd edition, 1972, ISBN 978-0-13-223319-3
3	Engineering Plasticity, R A C Slater, The Mac Milan Press Ltd., 1st Edition, 1977, ISBN 978-1-349-02162-8
4	Applied Elasticity, C.T. Wang, Mc Graw Hill Book Co.*ISBN* 13: 9780070681255, 2003.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

Semester: II						
ADVANCED THEORY OF VIBRATIONS						
Course Code	**:**	**18MMD22**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
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. Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation	
Unit – II	**08 Hrs**
Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, Vibration dampers. Vibration Measurement and applications : Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibrationexciters, Signal analysis.	
Unit – III	**08 Hrs**
Modal analysis: Dynamic Testing of machines and Structures, Experimental Modal analysis. **Vibrations of beams:** equation of motion, modal analysis, approximate methods, initial value problem, forced vibrations, special problems, wave propagation Vibrations of membranes: equations of motion, modal analysis, approximate methods. **Vibrations of plates:** equations of motion, modal analysis, approximate methods	
Unit – IV	**08 Hrs**
Random Vibrations : Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response.	
Unit –V	**08 Hrs**
Signature analysis and preventive maintenance, Vibration testing equipment, signal generation, measuring and conditioning instruments. **Vibration testing equipment:** Signal analysis instruments, Vibration signatures and standards	

Course Outcomes:

After going through this course the student will be able to:

CO1: Construct Equations of motion based on free body diagrams

CO2: Analyse systems under free and forced vibrations for natural frequency of vibration

CO3: Evaluate Mechanical Systems are using modal analysis

CO4: Develop solutions through testing for vibrations and signature analysis techniques

Reference Books:	
1	Mechanical Vibrations, S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill, 2007.ISBN-10: 1439062129
2	Theory of Vibration with Application, William T. Thomson, Marie Dillon Dahleh, Prentice Hall Edition, ISBN, 0748743804, 2011
3	Vibrations & Acoustics, Sujatha, Tata McGraw Hill Edition, ISBN: 9780070148789, 2013
4	Mechanical Vibrations, S.S.Rao, Pearson Education, 4th ed., ISBN 978-0-13-212819-3, 2012

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
RESEARCH METHODOLOGY						
Course Code	**:**	**18IM23**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Overview of Research: Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.	
Unit – II	**08 Hrs**
Data and data collection: Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **Sampling Methods:** Probability sampling and Non-probability sampling	
Unit – III	**08 Hrs**
Processing and analysis of Data: Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools	
Unit – IV	**08 Hrs**
Advanced statistical analyses: Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.	
Unit-V	**07 Hrs**
Essentials of Report writing and Ethical issues: Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism **Case studies:** Discussion of case studies specific to the domain area of specialization	

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the principles and concepts of research types, data types and analysis procedures.

CO2: Apply appropriate method for data collection and analyze the data using statistical principles.

CO3: Present research output in a structured report as per the technical and ethical standards.

CO4: Create research design for a given engineering and management problem situation.

Reference Books:	
1	Research Methodology Methods and techniques, Kothari C.R.,New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2	Management Research Methodology, Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	The Research Methods Knowledge Base, William M. K. Trochim, James P. Donnelly, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Statistics for Management, Levin, R.I. and Rubin, D.S., 7th Edition, Pearson Education: New Delhi.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
MINOR PROJECT						
Course Code	**:**	**18 MDM 24**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**0:0:10**	**SEE Marks**	**:**	**100**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes:

After going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply resource managements skills for projects
CO4: Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of FOUR members : guide, two senior faculty members and Head of the Department.

Phase	Activity	Weightage
I	Synopsis submission, Preliminary seminar for the approval of selected topic and Objectives formulation	20%
II	Mid-term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

****Phase wise rubrics to be prepared by the respective departments**

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1.	Brief write-up about the project	5%
2.	Presentation / Demonstration of the project	20%
3.	Methodology and Experimental Results & Discussion	25%
4.	Report	20%
5.	Viva Voce	30%

Semester: II						
THEORY OF PLATES AND SHELLS (Group C: Core Elective)						
Course Code	**:**	**18MMD2C1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
General Introduction: Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness- energy principles and variational methods in elasticity- virtual work-external and internal virtual work variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential- applications.	
Unit – II	**11 Hrs**
Classical Theory Of Plates: Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis	
Unit – III	**11 Hrs**
Buckling Analysis of Rectangular Plates: Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis	
Unit – IV	**10 Hrs**
Vibration of Plates: Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported Levy's solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis.	
Unit –V	**10 Hrs**
Analysis of Thin Elastic Shells of Revolution: Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution- stress resultants- equations of motion of thin shells, analytical solution for thin cylindrical shells- membrane theory- flexure under axisymmetric loads, shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Apply the structural mechanics approximations of membrane, plates and shells.

CO2: Develop simple modifications to the membrane plate and shell theories

CO3: Describe the static, dynamic, and non-linear motion of membrane, plateand shell structures.

CO4: Analyze numerical problems in shells of revolution

Reference Books:	
1	Theory and Analysis of Elastic Plates & Shells, Reddy,J.N., C.R.C. Press, NY, USA, 2nd Edition, ISBN 9780849384158
2	Theory and Analysis of Plates, Szilard, R., Prentice Hall Inc., 1999,ISBN 0-12-9353336-2
3	Theory of Plates and Shells, Timoshenko, S. and Krieger S.W, McGraw Hill Book Company, New York 1990, ISBN 0-13-913426-3
4	Stresses in shells, Wilhelm Flügge, Springer –Verlag, *ISBN* 978-3-662-01028-0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
DESIGN FOR MANUFACTURE & ASSEMBLY (Group C: Core Elective)						
Course Code	**:**	**18MPD2C2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction to Design for Manufacture & Assembly: Steps in DFMA, Advantages of DFMA, Design guidelines for Manual Assembly and High Speed Automatic and Robotic Assembly. **Geometrical Dimensioning & Tolerance –** Dimensions & Tolerance, Limits, Fits and Tolerances, Hole and Shaft Basis, Three datum – functional, machining and manufacturing, geometrical and form tolerance, conventional and advanced tools and techniques for measurements, numerical	
Unit – II	**11 Hrs**
Metal Casting Processes – Gravity Die Casting : compute the dimensions for Pattern, Mould, based on materials to be cast – ferrous and non-ferrous alloys, influence of parting line, cast holes, special sand cores, shrinkage compensation, numericals, **Pressure Die Casting:** Die casting alloys, machine selection, operation, sub-systems, post-processing equipments, mould design, number of cavities, manufacturing and assembly of moulds, design principles.	
Unit – III	**11 Hrs**
Design for Injection Molding – Injection moulding systems – injection subsystem, ejection system, clamping and feeding system, machine sizing, materials for injection moulding and its properties, injection mould design – cavity and core, manufacturing processes for moulds, operation and cycle time.	
Unit – IV	**10 Hrs**
Design for Powder Metallurgy Processes: Introduction to PM process, blending and mixing, compaction, sintering processes. Tooling materials, heat treatment, surface treatments and preparation of green compacts, Press tools for PM process – load, tooling layout, capacity; sintering furnace and influence of process and materials parameters on shrinkage.	
Unit –V	**10 Hrs**
Design for Sheet Metal Processing : Design of moulds for shearing, piercing, bending, deep drawing, progressive die operation, selection of press – hydraulic and electric, sub-systems, turret operation, cycle time calculation, laser cutting of sheet metals. **Cost Estimation** for sand casting, pressure die casting, injection moulding, PM process and sheet metal processes.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the concept of DFMA and GD&T

CO2: Apply engineering products and suggest suitable manufacturing process

CO3: Evaluate the influence of design, material and manufacturing processes on product assembly

CO4: Develop appropriate manufacturing and assembly processes for a given product

Reference Books:	
1	Product Design for Manufacture and Assembly, Geoffrey Boothroyd, Peter Dewhurst, Winston Knight Marcel Dekker, Inc., Newyork - Second Revision, ISBN 0-8247-0584-X
2	Designing for Manufacturing, Harry Peck, Pitman Publications,1983, ISBN: 1-85233-810-5
3	Dimensioning and Tolerance for Quantity Production, Merhyle F Spotts, Englewood Cliffs, Prentice Hall, 5th edition, ISBN: 2-95433-956-3
4	Design for manufacturing – a structured approach, Corrado Colig, BH publishers, 3rd Edition, ISBN :978-0750673419

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
COMPUTER APPLICATION IN DESIGN (Group C: Core Elective)						
Course Code	**:**	**18MCM2C3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

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, Following a line: Parameters

Unit – II	**11 Hrs**

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

Unit – III	**11 Hrs**

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

Unit – IV	**10 Hrs**

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 normals for curves in a plane, Tangents and normals in three dimensions

Unit –V	**10 Hrs**

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 in a 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:
After going through this course the student will be able to:

CO1: Discuss the concepts of Computer Graphics in CAD in product development

CO2: Apply the concepts of CAD in the manufacturing industry

CO3: Analyze the concepts of computer Aided Design

CO4: Evaluating the techniques involved in CAD

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

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
ADVANCED MACHINE DESIGN (Group D: Core Elective)						
Course Code	**:**	**18MMD2D1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
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	
Unit – II	**11 Hrs**
Stress-Life (S-N) Approach: S-N curves, the statistical nature of fatigue test data, General S-N behaviour, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach. Strain-Life(ε-N)approach: Monotonic stress-strain behaviour ,Strain controlled test methods, Cyclic stress-strain behaviour, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	
Unit – III	**11 Hrs**
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 30 stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, and applications of fracture mechanics to crack growth at notches.	
Unit – IV	**10 Hrs**
Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.	
Unit –V	**10 Hrs**
Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosive wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength	

Course Outcomes:

After going through this course the student will be able to:

CO1: Identify and explain the types of fractures of engineered materials and their characteristic features

CO2: Develop a detailed understanding of S-N curves, S-N approach & behaviour

CO3: Understand the differences in the classification of fracture mechanics (LEFM and EPFM) and how their corresponding parameters can be utilized to determine conditions under which engineering materials will be liable to fail catastrophically in service.

CO4: Appreciate the theoretical basis of the experimental techniques utilized for surface failure analysis

Reference Books:	
1	Metal Fatigue in engineering, Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, John wiley Newyork, Second edition. 2001. ISBN: 978-1-933489-67-4
2	Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, Newyork 1992. ISBN: 988-3-955783-62-2
3	Machine Design, Robert L. Norton, Pearson Education India, 2000, ISBN 0-06-008493-3
4	Fatigue of Materials, S.Suresh, Cambridge University Press, -1998

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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
ROBOTICS & AUTOMATION (Group D: Core Elective)						
Course Code	**:**	**18MCM2D2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
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, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Control Approaches of Robots	
Unit – II	**11 Hrs**
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	
Unit – III	**11 Hrs**
Robotic Workspace & Motion Trajectory: 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.	
Unit – IV	**10 Hrs**
Dynamics of Robotic Manipulators: Introduction, Bond Graph Modeling of Robotic Manipulators, Examples of Bond Graph Dynamic Modeling of Robotic Manipulator. Brief Discussion on Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Preliminary Definitions, Generalized Robotic Coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic Mass Distribution & Inertia Tensors, Newton's Equation, Euler Equations, The Lagrangian& Lagrange's Equations. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass, Dynamic Equations of Motion for A General Six Axis Manipulator.	
Unit –V	**10 Hrs**
Autonomous Robot: Locomotion Introduction, Key issues for locomotion Legged Mobile Robots Leg configurations and stability Examples of legged robot locomotion Wheeled Mobile Robots Wheeled locomotion: the design space Wheeled locomotion: case studies Mobile Robot Kinematics Introduction Kinematic Models and Constraints Representing robot position Forward kinematic models Wheel kinematic constraints Robot kinematic constraints, Mobile Robot manoeuvrability Degree of mobility Degree of steerability Robot manoeuvrability.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Analyze the manipulator design including actuator, drive and sensor issues

CO2: Calculate the forward kinematics, inverse kinematics and Jacobian industrial robots

CO3: Solve trajectory and dynamic related robotic problems

CO4: Evaluate the different configurations and stability of autonomous robots

	Reference Books:
1	A Robot Engineering Textbook, Mohsen Shahinpoor, Harper & Row publishers, New York. ISBN:006045931X
2	Robotics, control vision and intelligence, Fu, Lee and Gonzalez, McGraw Hill International. ISBN:0070226253
3	Introduction to Robotics, John J. Craig, Addison Wesley Publishing, ISBN:0201543613
4	Autonomous mobile robots, Roland Illah R. Siegwart Nourbakhsh, The MIT Press Cambridge, Massachusetts London, England, 2004.ISBN:0262015358

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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
ADVANCED FINITE ELEMENT ANALYSIS (Group D: Core Elective)						
Course Code	**:**	**18MMD2D3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Basics of Finite Element Analysis : Shape function of the linear bar element, quadratic bar element, 2-D Constant strain triangular element, 2-D linear triangular element, 4 noded quadrilateral element, 9-noded quadrilateral element and scrindipidy elements. Stiffness, traction and body force equations for 1-D 2 noded element, 2-D truss element, CST element and 4 noded quadrilateral elements and related problems.	
Unit – II	**11 Hrs**
Axisymmetric Solids: Structures of Revolution, Axisymmetric Solid Iso-P Elements, Iso-P Quadrilateral Ring Elements, A Complete Axisymmetric FEM Program. Axisymmetric Solid Benchmark Problems.	
Unit – III	**11 Hrs**
Part 3: General Solids: Solid Elements: Overview. The Linear Tetrahedron, The Quadratic Tetrahedron.The 8-Node Hexahedron. The 20-Node Hexahedron. Pyramid solid elements: a successful application of morphing.	
Unit – IV	**10 Hrs**
Dynamic Analysis using Finite Element Method: Introduction – vibrational problems – equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams – consistent mass matrices – element equations –solution of eigenvalue problems – vector iteration methods – normal modes – transient vibrations – modeling of damping – mode superposition technique – direct integration methods.	
Unit –V	**10 Hrs**
Applications in Heat Transfer & Fluid Mechanics: One dimensional heat transfer element – application to one-dimensional heat transfer problems- scalar variable problems in 2-Dimensions – Applications to heat transfer in 2- Dimension – Application to problems in fluid mechanics in 2-D	

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain the fundamentals of finite element methods

CO2: Develop the knowledge to analyses, structures under static and dynamic conditions.

CO3: Selection of numerical techniques for solving engineering problems

CO4: Explore the use of finite element method knowledge to implement industrial project

Reference Books:	
1	Introduction to Finite Elements in Engineering, Chandrupatla T. R., and Belegundu, A.D., Prentice Hall, 2003.
2	An Introduction to the Finite Element Method, Reddy, J. N. 3rd Edition, McGraw-Hill Science/Engineering/Math, 2005.
3	The Finite Element Method in Engineering, S. S. Rao, Fifth Edition, Elsevier Publications.
4	Advanced Finite Element Methods and Applicatons, Thomas Apel and Olaf Steinbach, Springer Publications, ISBN 978–3–642–30315–9, 2013

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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
BUSINESS ANALYTICS (Group G: Global Elective)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.	
Unit – II	**08 Hrs**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	
Unit – III	**08 Hrs**
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.	
Unit – IV	**08 Hrs**
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.	
Unit –V	**07 Hrs**
Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	

Course Outcomes:
After going through this course the student will be able to:

CO1: Explore the concepts, data and models for Business Analytics.

CO2: Analyze various techniques for modelling and prediction.

CO3: Design the clear and actionable insights by translating data.

CO4: Formulate decision problems to solve business applications

Reference Books:	
1	Business Analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2	The Value of Business Analytics: Identifying the Path to Profitability,Evan Stubs , John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881, 1st Edition 2014
3	Business Analytics, James Evans, Pearsons Education 2nd Edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley; 1st Edition, 2013.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
INDUSTRIAL & OCCUPATIONAL HEALTH AND SAFETY (Group G: Global Elective)						
Course Code	**:**	**18CV2G02**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**07 Hrs**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.	
UNIT – II	**09 Hrs**
Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.	
UNIT – III	**09 Hrs**
Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.	
UNIT – IV	**07 Hrs**
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	
UNIT – V	**07 Hrs**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.	

Course Outcomes:
After going through this course the student will be able to:

CO1: Explain the Industrial and Occupational health and safety and its importance.

CO2: Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.

CO3: Characterize the different type materials, with respect to safety and health hazards of it.

CO4: Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

	Reference Books:
1	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
2	Maintenance Engineering Principles, Practices & Management, H. P. Garg, S. Chand and Company, New Delhi, 2009. ISBN:9788121926447
3	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition, International Labour Office – Geneva: ILO, 2008. ISBN 978-92-2-120454-1
4	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
MODELING USING LINEAR PROGRAMMING (Group G: Global Elective)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	
Unit – II	**08 Hrs**
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	
Unit – III	**08 Hrs**
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	
Unit – IV	**08 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	
Unit –V	**07 Hrs**
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	

Course Outcomes:
After going through this course the student will be able to:

CO1: Explain the various Linear Programming models and their areas of application.

CO2: Formulate and solve problems using Linear Programming methods.

CO3: Develop models for real life problems using Linear Programming techniques.

CO4: Analyze solutions obtained through Linear Programming techniques.

Reference Books:	
1	Operation Research An Introduction, Taha H A, PHI, 8th Edition, 2009, ISBN: 0130488089.
2	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, John Wiley & Sons (Asia) Pvt Ltd, 2nd Edition, 2000, ISBN 13: 978-81-265-1256-0
3	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, Tata McGraw Hill 9th Edition, 2012, ISBN 13: 978-0-07-133346-7
4	Operations Research Theory and Application, J K Sharma, Pearson Education Pvt Ltd, 4th Edition, 2009, ISBN 13: 978-0-23-063885-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
PROJECT MANAGEMENT (Group G: Global Elective)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	
Unit – II	**08 Hrs**
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study - a schematic diagram, objectives of capital budgeting	
Unit – III	**08 Hrs**
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	
Unit – IV	**08Hrs**
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	
Unit-V	**07 Hrs**
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Explain project planning activities that accurately forecast project costs, timelines, and quality.

CO2: Evaluate the budget and cost analysis of project feasibility.

CO3: Analyze the concepts, tools and techniques for managing projects.

CO4: Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations

Reference Books:	
1	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, Tata McGraw Hill Publication, 8th Edition, 2010, ISBN 0-07-007793-2.
2	Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
4	Project Management – Planning and Controlling Techniques, Rory Burke, John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
ENERGY MANAGEMENT (Group G: Global Elective)						
Course Code	**:**	**18CH2G05**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**08 Hrs**
Energy conservation: Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.	
Unit-II	**08 Hrs**
Wet Biomass Gasifiers: Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages	
Unit –III	**08 Hrs**
Dry Biomass Gasifiers : Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.	
Unit –IV	**08 Hrs**
Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication. **Wind Energy:** Classification, Factors influencing wind, WECS & classification.	
Unit –V	**07 Hrs**
Alternative liquid fuels: Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet. Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Understand the use alternate fuels for energy conversion

CO2: Develop a scheme for energy audit

CO3: Evaluate the factors affecting biomass energy conversion

CO4: Design a biogas plant for wet and dry feed

Reference Books:	
1	Nonconventional energy, Ashok V Desai, 5th Edition, 2011, New Age International (P) Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN:9788120343863.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
INDUSTRY 4.0 **(Group G: Global Elective)**						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit – II	**08 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	
Unit – III	**08 Hrs**
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	
Unit – IV	**08 Hrs**
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	
Unit –V	**08 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals

CO2: Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services

CO3: Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits

CO4: Evaluate the effectiveness of Cloud Computing in a networked economy

	Reference Books:
1	INDUSTRY 4.0 THE INDUSTRIAL INTERNET OF THINGS, Alasdair Gilchrist, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, Springer, 2018 ISBN 978-3-319-57869-9.
3	Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Ovidiu Vermesan and Peer Friess, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4	The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
ADVANCED MATERIALS (Group G: Global Elective)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	
Unit – II	**08 Hrs**
Non Metallic Materials: Classification of n on metallic materials, Rubber: Properties, processing and applications. Plastics: Thermosetting and Thermoplastics, Applications and properties. Ceramics: Properties and applications. Adhesives: Properties and applications. Optical fibers: Properties and applications. Composites : Properties and applications.	
Unit – III	**08 Hrs**
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	
Unit – IV	**08 Hrs**
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	
Unit –V	**08 Hrs**
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	

Course Outcomes:
After going through this course the student will be able to:

CO1: Describe metallic and non-metallic materials

CO2: Explain preparation of high strength Materials

CO3: Integrate knowledge of different types of advanced engineering Materials

CO4: Analyse problem and find appropriate solution for use of materials.

Reference Books:	
1	The Science & Engineering of Materials, Donald R. Askeland, and Pradeep P. Fulay, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Nanotechnology, Gregory L. Timp, 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Material Science and Metallurgy, Dr. VD Kodgire and Dr. S V Kodgire, 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	Processing and Fabrication of Advanced Materials, N Bhatnagar, T S Srivatsan, 2008, IK International, ISBN: 978819077702

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Group G: Global Elective)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**08 Hrs**
Introduction to composite materials Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.	
Unit – II	**08 Hrs**
Polymer matrix composites (PMC) Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers, Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**	
Unit -III	**08 Hrs**
Ceramic matrix composites and special composites Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics – need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.	
Unit –IV	**07 Hrs**
Metal matrix composites Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries.	
Unit –V	**08 Hrs**
Polymer nano composites Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles. Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques. Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM. Mechanical and Rheological properties of Polymer Nano composites. Gas barrier,	

Course Outcomes:
After going through this course the student will be able to:

CO1: Understand the purpose and the ways to develop new materials upon proper combination of known materials.

CO2: Identify the basic constituents of a composite materials and the list the choice of materials available

CO3: Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.

CO4: Get insight to the possibility of replacing the existing macro materials with nanomaterials.

Reference Books:	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition, Springer - verlag Gmbh, 2012 , ISBN: 978-0387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6th Edition-Cengage, Publishers,2013, ISBN: 13: 978-8131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, 2014, ISBN: 13: 978-0137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, 2010, ISBN: 10-9781498761666, 1498761666

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
PHYSICS OF MATERIALS (Group G: Global Elective)						
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Crystal Structure Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg's law, Powder method, Bragg's spectrometer, Qualitative Analysis of Crystal structure using XRD, Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.	
Unit – II	**08 Hrs**
Dielectric Materials Basic concepts, Langevin's Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polarizability as a function of frequency), Qualitative discussion of Internal Field and Claussius Mossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect, Coupling factor, spontaneous polarization, Piezolelectricty in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.	
Unit – III	**08 Hrs**
Magnetic Materials Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron and SQUID.	
Unit – IV	**07 Hrs**
Semiconducting Materials Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement-quantum wires and dots, size dependent properties, Top down approach, Fabrication process by Milling and Lithography, Bottom up approach, fabrication process by vapour phase expansion and vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.	
Unit –V	**08 Hrs**
Novel Materials Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoeleasticity, Transformation hysteresis, Super elasticity, Characterization technique-Differntial Scanning calorimetry, Preparation technique- spin coating, Nitinol, CuAlNi alloy and applications. Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys, Carbon nanotubes, Graphene- Properties and Applications.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Apply the principles of Physics in Engineering.

CO2: Apply the knowledge of Physics for material analysis.

CO3: Identify and Analyze Engineering Problems to achieve practical solutions.

CO4: Develop solutions for Problems associated with Technologies.

	Reference Books:
1	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.
2	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971- 51-180.
3	Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar, S Chand Publishing, Reprint 2015.
4	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Semester: II						
ADVANCED STATISTICAL METHODS (Group G: Global Elective)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Sampling Techniques: Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement), Sampling distribution of proportions, Expectation and standard error of sample mean and proportion, Sampling distributions of differences and sums.	
Unit – II	**08 Hrs**
Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Confidence intervals-population mean (large sample).	
Unit – III	**08 Hrs**
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples. Simple and composite hypotheses. Null and alternative hypotheses. Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Exact and asymptotic tests of proportions. Chi squared test for goodness of fit (Relevant case studies).	
Unit – IV	**07 Hrs**
Linear Statistical Models: Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell (Relevant case studies).	
Unit –V	**09 Hrs**
Linear Regression: Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.	

Course Outcomes:

After going through this course the student will be able to:

CO1: Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.

CO2: Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions.

CO3: Analyze the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.

CO4: Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations

	Reference Books:
1	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, World Press Private Limited, 3rd Edition, 1968, ISBN-13: 978-8187567806.
2	Applied Statistics and Probability for Engineers, D. C. Montgomery and G. C. Runger, John Wiley & Sons, Inc., 3rd Edition, 2003, ISBN 0-471-20454-4.
3	Fundamentals of Mathematical Statistic - A Modern Approach, S.C. Gupta, V.K. Kapoor, S Chand Publications, 10th Edition, 2000, ISBN 81-7014-791-3.
4	Regression Analysis: Concepts and Applications, F. A. Graybill and H. K. Iyer, Belmont, Calif.: Duxbury Press, 1994, ISBN-13: 978-0534198695.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks.

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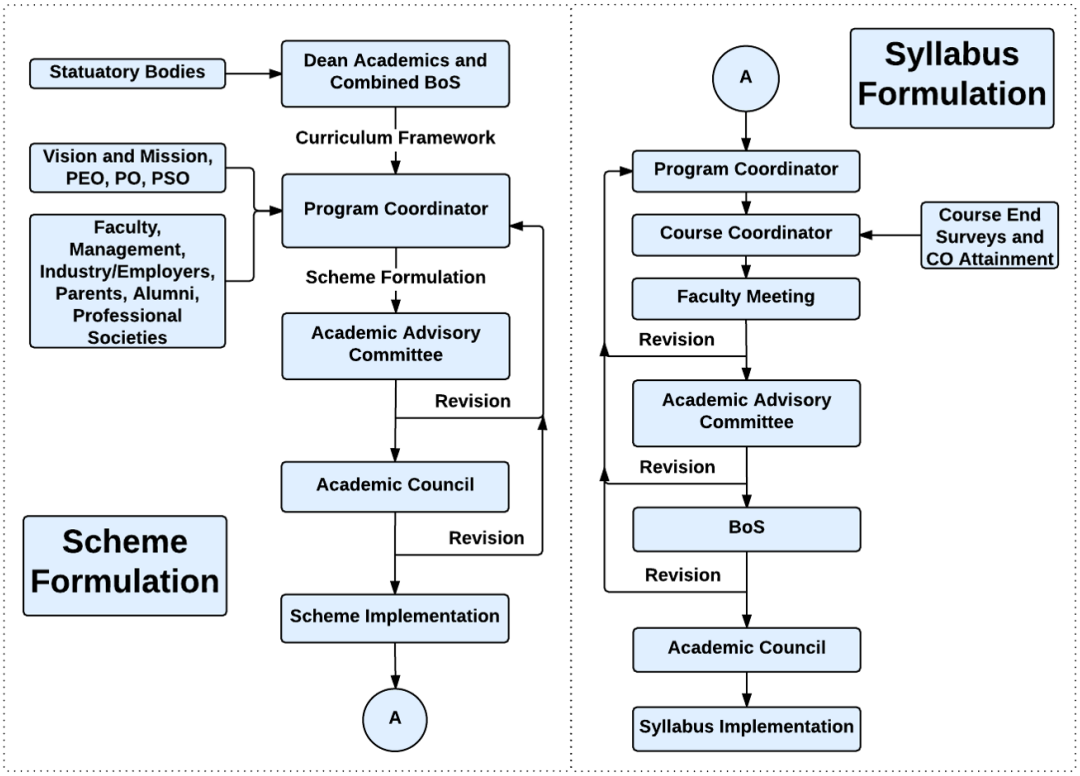
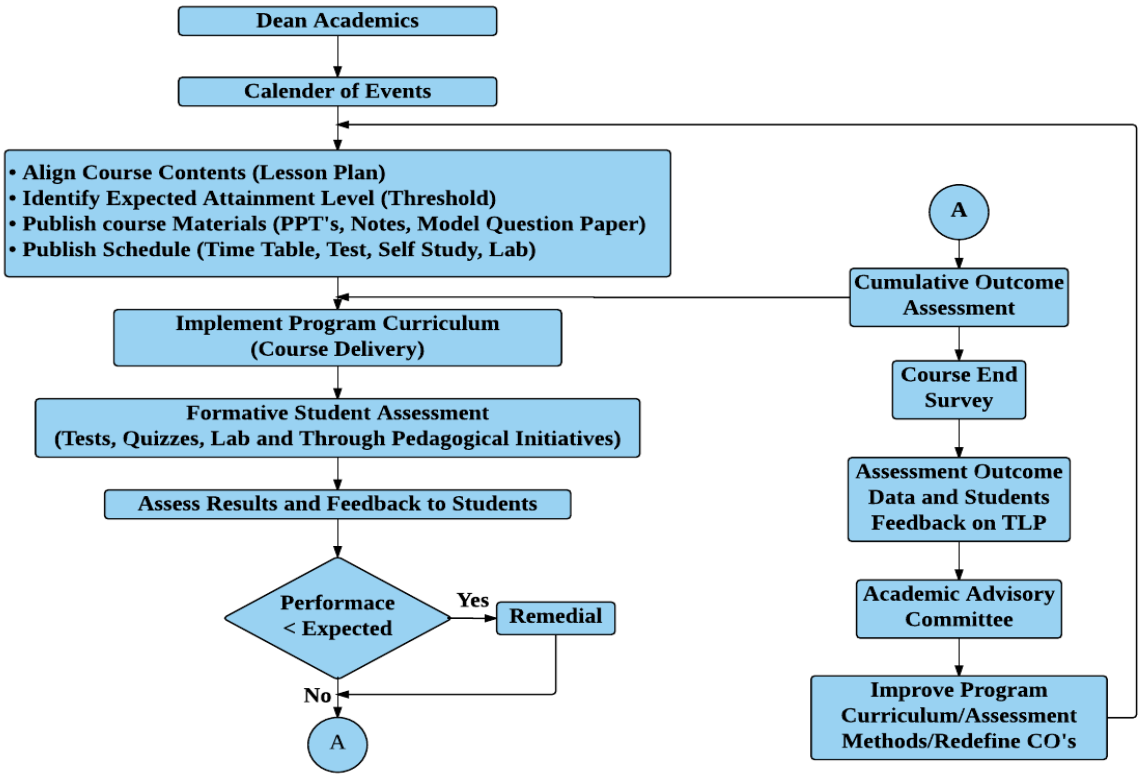
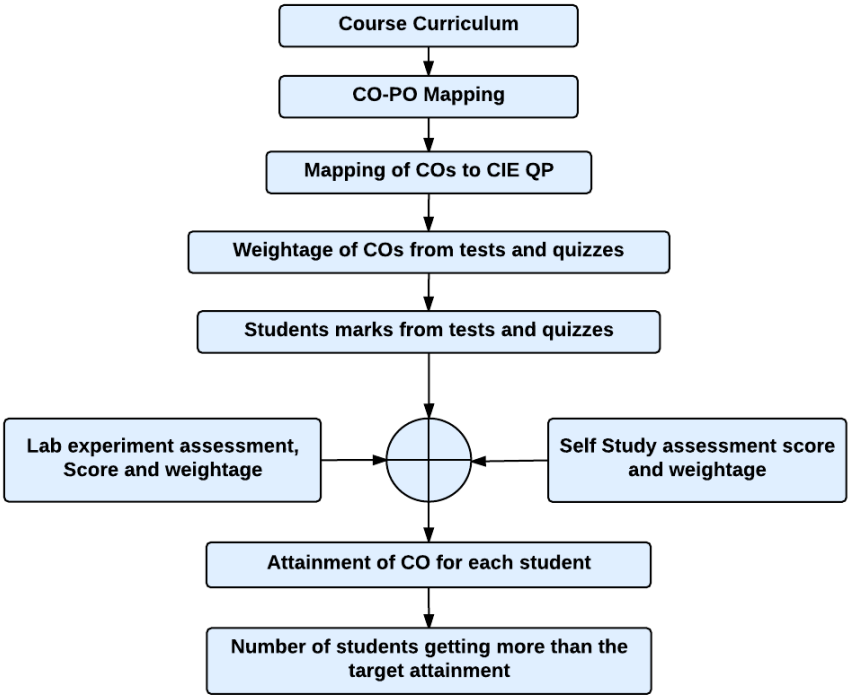
Curriculum Design Process



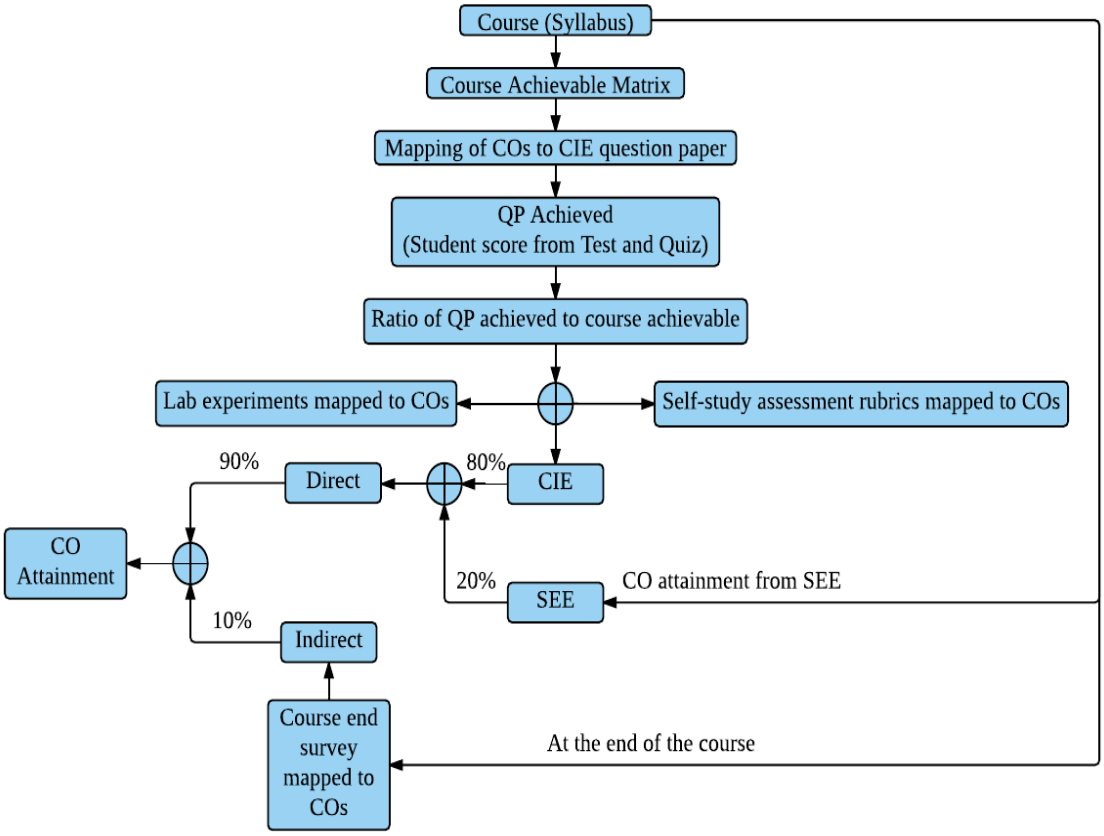
Academic Planning And Implementation



Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process