



# **RV COLLEGE OF ENGINEERING®**

**(Autonomous Institution Affiliated to VTU, Belagavi)**

**RV Vidyaniketan Post, Mysuru Road**

**Bengaluru – 560059**



## **Scheme and Syllabus of I to IV Semester (Autonomous System of 2018 Scheme)**

### **Master of Technology (M.Tech) in 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**

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

## **QUALITY POLICY**

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

## **CORE VALUES**

Professionalism, Commitment, Integrity, Team Work and Innovation.



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**DEPARTMENT OF  
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11. Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
12. Imbibing social and ethical values in students, staff and faculty through personality development programs

## **PROGRAMME 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	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional 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.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Signal Processing & Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

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**RV COLLEGE OF ENGINEERING®, BENGALURU-560 059**  
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**DEPARTMENT OF MECHANICAL ENGINEERING**

**M.Tech Program in Machine Design**

<b>FIRST SEMESTER CREDIT SCHEME</b>							
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>BoS</b>	<b>Credit Allocation</b>			
				<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Credits</b>
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 Group-A	ME	3	1	0	4
6	18XXX1BX	Elective Group-B	ME/CSE	4	0	0	4
<b>Total number of Credits</b>				<b>19</b>	<b>1</b>	<b>2</b>	<b>22</b>
<b>Total Number of Hours / Week</b>				<b>19</b>	<b>2</b>	<b>4</b>	<b>25</b>

<b>SECOND SEMESTER CREDIT SCHEME</b>							
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>BoS</b>	<b>Credit Allocation</b>			
				<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Credits</b>
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
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<b>Total number of Credits</b>				<b>21</b>	<b>01</b>	<b>03</b>	<b>25</b>
<b>Total Number of Hours / Week</b>				<b>21</b>	<b>02</b>	<b>06</b>	<b>29</b>



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

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<b>Sl. No.</b>	<b>Host Dept</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Credits</b>
1.	CS	18CS2G01	Business Analytics	03
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	03
3.	IM	18IM2G03	Modelling using Linear Programming	03
4.	IM	18IM2G04	Project Management	03
5.	CH	18CH2G05	Energy Management	03
6.	ME	18ME2G06	Industry 4.0	03
7.	ME	18ME2G07	Advanced Materials	03
8.	CHY	18CHY2G08	Composite Materials Science and Engineering	03
9.	PHY	18PHY2G09	Physics of Materials	03
10.	MAT	18MAT2G10	Advanced Statistical Methods	03

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**DEPARTMENT OF MECHANICAL ENGINEERING**

**M.Tech Program in MACHINE DESIGN**

<b>THIRD SEMESTER CREDIT SCHEME</b>							
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>BoS</b>	<b>Credit Allocation</b>			
				<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1	18MMD31	Fracture Mechanics	ME	4	1	0	<b>5</b>
2	18MMD32	Internship	ME	0	0	5	<b>5</b>
3	18MMD33	Major Project: Phase-I	ME	0	0	5	<b>5</b>
4	18MMDEX	Professional Elective-E	ME	4	0	0	<b>4</b>
<b>Total number of Credits</b>				<b>8</b>	<b>1</b>	<b>10</b>	<b>19</b>
<b>Total Number of Hours/Week</b>				<b>8</b>	<b>2</b>	<b>20</b>	<b>30</b>

<b>SEMESTER : III</b>		
<b>GROUP E: PROFESSIONAL ELECTIVES</b>		
<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>
1	18MMD3E1	Mechatronics System Design
2	18MPD3E2	Surface Engineering
3	18MMD3E3	Experimental Mechanics

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<b>Sl. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>BoS</b>	<b>Credit Allocation</b>			
				<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1	18MMD41	Major Project : Phase-II	ME	0	0	20	<b>20</b>
2	18MMD42	Technical Seminar	ME	0	0	2	<b>2</b>
<b>Total number of Credits</b>				<b>0</b>	<b>0</b>	<b>22</b>	<b>22</b>
<b>Total Number of Hours / Week</b>				<b>0</b>	<b>0</b>	<b>44</b>	<b>44</b>



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

<b>Unit – I</b>					<b>10 Hrs</b>
<b>Statistics:</b> 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.					
<b>Unit – II</b>					<b>10 Hrs</b>
<b>Probability distributions:</b> Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard Distributions-Binomial, Exponential, Normal and Gamma distributions.					
<b>Unit – III</b>					<b>11 Hrs</b>
<b>System of linear equations and eigen value problems:</b> 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.					
<b>Unit – IV</b>					<b>11 Hrs</b>
<b>Numerical solution of differential equations:</b> 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.					
<b>Unit – V</b>					<b>10 Hrs</b>
<b>Engineering optimization:</b> 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.					

<b>Course Outcomes:</b>	
<b>After going through this course the student will be able to:</b>	
<b>CO1</b>	Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various field engineering.
<b>CO2</b>	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.
<b>CO3</b>	Analyze the physical problem to establish a statistical / mathematical model and use an appropriate method to solve and optimize the solution.
<b>CO4</b>	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.

<b>Reference Books:</b>	
<b>1</b>	Theory and Problems of probability, Seymour Lipschutz and Marc lars Lipson,Schaum's Outline Series, 2nd edition, ISBN: 0-07-118356-6.
<b>2</b>	Introductory method of numerical analysis, S. S. Sastry, Prentice-Hall India Pvt. Ltd. 4th edition, 2009, ISBN : 81-203-1266-X.
<b>3</b>	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.
<b>4</b>	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
<b>Introduction to Composite Materials:</b> Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepregs, and sandwich construction. Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications					
<b>Macro Mechanics of a Lamina:</b> 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
<b>Micro Mechanical Analysis of a Lamina:</b> Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths					
<b>Failure Criteria:</b> 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
<b>Macro Mechanical Analysis of Laminate:</b> 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
<b>Analysis of Composite Structures:</b> 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
<b>Manufacturing and Testing:</b> 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.					
<b>Applications:</b> 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, 2 <sup>nd</sup> 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

<b>Unit – I</b>					<b>10 Hrs</b>
<b>Geometry of Motion:</b> 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.					
<b>Unit – II</b>					<b>11 Hrs</b>
<b>Generalized Principles of Dynamics:</b> 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.					
<b>Unit – III</b>					<b>11 Hrs</b>
<b>Analytical Methods of Dimensional Synthesis:</b> 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					
<b>Unit – IV</b>					<b>10 Hrs</b>
<b>Graphical Methods of Dimensional Synthesis:</b> Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Analytical 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.					
<b>Unit –V</b>					<b>10 Hrs</b>
<b>Spatial Mechanisms:</b> Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.					
<b>Unit –VI Kinematics and Dynamics of Mechanisms Lab</b>					<b>26 Hrs</b>
Modelling 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.					



<b>Course Outcomes:</b> <b>After going through this course the student will be able to:</b>	
<b>CO1</b>	Describe the fundamental concepts of kinematics and dynamics
<b>CO2</b>	Design and analyze mechanism and kinematic linkages
<b>CO3</b>	Identify, formulate and solve engineering dynamic problems
<b>CO4</b>	Determine forces acting on the parts of machines used in Industries

<b>Reference Books:</b>	
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)**

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						
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				

<b>Unit – I</b>					<b>03 Hrs</b>
<b>Communication Skills:</b> Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. <b>Resume Writing:</b> Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.					
<b>Unit – II</b>					<b>08 Hrs</b>
<b>Quantitative Aptitude and Data Analysis:</b> Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. <b>Reasoning – a. Verbal -</b> Blood Relation, Sense of Direction, Arithmetic & Alphabet. <b>b. Non- Verbal reasoning -</b> Visual Sequence, Visual analogy and classification. <b>Analytical Reasoning -</b> Single & Multiple comparisons, Linear Sequencing. <b>Logical Aptitude -</b> 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. <b>Verbal Analogies/Aptitude –</b> introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving					
<b>Unit – III</b>					<b>03 Hrs</b>
<b>Interview Skills:</b> 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					
<b>Unit – IV</b>					<b>03 Hrs</b>
<b>Interpersonal and Managerial Skills:</b> 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					
<b>Unit – V</b>					<b>07 Hrs</b>
<b>Motivation:</b> Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). <b>Leadership Skills:</b> Ethics and Integrity, Goal Setting, leadership ability.					

<b>Course Outcomes:</b>	
<b>After going through this course the student will be able to:</b>	
<b>CO1:</b>	Develop professional skill to suit the industry requirement.
<b>CO2:</b>	Analyze problems using quantitative and reasoning skills
<b>CO3:</b>	Develop leadership and interpersonal working skills.
<b>CO4:</b>	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, 1 <sup>st</sup> 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 (Professional Elective-A)						
Course Code	:	18MPD1A1		CIE Marks	:	100
Credits L: T: P	:	3:1:0		SEE Marks	:	100
Hours	:	39L+26T		SEE Duration	:	3 Hrs

<b>Unit – I</b>					<b>07 Hrs</b>
<b>Design for quality</b> : 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.					
<b>Unit – II</b>					<b>08 Hrs</b>
<b>Quality Function Deployment</b> –Introduction, QFD team, benefits, voice of customer, organisation of information, house of quality, QFD process <b>Design of Experiments:</b> Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design					
<b>Unit – III</b>					<b>08 Hrs</b>
<b>Failure Mode Effect Analysis:</b> Refining geometry and layout, Failure tree analysis, Defects and failure modes Techniques of failure analysis, Field inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.					
<b>Unit – IV</b>					<b>08 Hrs</b>
<b>Statistical Consideration in Product Design and Development</b> 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					
<b>Unit –V</b>					<b>08 Hrs</b>
<b>Six Sigma</b> – 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					

<b>Course Outcomes:</b>	
<b>After going through this course, the student will be able to:</b>	
<b>CO1</b>	Identify the importance of various principles of quality in product or service
<b>CO2</b>	Use statistical tools in product development
<b>CO3</b>	Apply basic risk analysis and experiment design techniques into practical cases
<b>CO4</b>	Demonstrate knowledge about Six sigma, Design of Experiments

<b>Reference Books:</b>	
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, 3 <sup>rd</sup> Edition, McGraw hill International Edition, ISBN: 0-07-116204-6

**Scheme of 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**

**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 (Professional Elective-A)						
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
<b>Introduction to Tribology:</b> 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
<b>Hydrodynamic Lubrications:</b> 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.					
<b>Journal Bearings:</b> 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
<b>Hydrostatic Bearings:</b> 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					
<b>Antifriction bearings:</b> Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.					
Unit – IV					08 Hrs
<b>EHL Contacts:</b> Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.					
<b>Porous Bearings:</b> 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
<b>Magnetic Bearings:</b> 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

<b>Reference Books:</b>	
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

**Scheme of 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**

**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 (Professional Elective-A)						
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
<b>Introduction to Hydraulic System:</b> Introduction, Basic hydraulic system, classification of hydraulic motors, hydraulic pumps, Performance of hydraulic motors, Hydraulic actuators, types of hydraulic actuators.					
<b>Control Components in Hydraulic Systems:</b> 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
<b>Maintenance of Hydraulic Systems:</b> 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
<b>Hydraulic circuit Design and Analysis:</b> 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
<b>Pneumatic Concepts:</b> 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 circuit, application of logic valves.					
<b>Design of Pneumatic Circuits:</b> 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
<b>Electro-Pneumatics:</b> 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.					
<b>Servo System and PLC Applications in Pneumatics:</b> 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

**Scheme of 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**

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

<b>Reference Books:</b>	
1	Artificial Intelligence – Structures and Strategies for Complex problem Solving, George F Luger, 6 <sup>th</sup> 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, 3 <sup>rd</sup> Edition, Pearson Publication, 2015, ISBN-13: 978-93-325-4351-5
3	Artificial Intelligence, Elaine Rich, Kevin Knight, 3 <sup>rd</sup> 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 (Professional Elective-B)						
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
<b>Introduction:</b> Need for unconventional machining processes, classification of non-traditional machining processes.					
<b>Abrasive Jet Machining (AJM):</b> 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.					
<b>Ultrasonic machining (USM):</b> Ultrasonic Machining System, Mechanics of cutting, Model proposed by Shaw – Grain Throwing Model, Grain Hammering Model; Parametric Analysis, Process Capabilities.					
Unit – II					11 Hrs
<b>Water Jet Cutting (WJC):</b> WJC Machine, Process Characteristics, Process Performance. Applications, Advantage and Limitations.					
<b>Abrasive Water Jet Machining (AWJM):</b> 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.					
<b>Abrasive Flow Machining (AFM):</b> Working Principle of Abrasive flow Machining System Process Variables,					
<b>Magnetic Abrasive Finishing (MAF) –</b> Working Principle of MAF, Material Removal and Surface Finish – Type and Size of Grains.					
Unit – III					11 Hrs
<b>LASER Beam Machining (LBM):</b> Production of LASERS, Working Principle of LASER Beam Machining, Types of Lasers – Solid State Lasers, Gas Lasers; Process Characteristics. Applications, Advantage and Limitations.					
<b>Plasma Arc Machining (PAM):</b> Working Principle, Plasma Arc Cutting System, Elements of Plasma Arc Cutting System, Process Performance.					
<b>Electron Beam Machining (EBM):</b> 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
<b>Electrochemical Machining (ECM):</b> 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.					
<b>Chemical Processes:</b> 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
<b>Non Destructive Testing:</b> 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.	

<b>Course Outcomes:</b> <b>After going through this course the student will be able to:</b>	
<b>CO1:</b>	Explain the principle, mechanism of metal removal of various unconventional machining processes.
<b>CO2:</b>	Analyses the process parameters and their effect on the component machined on various unconventional machining processes and tested using NDT techniques.
<b>CO3:</b>	Apply the concept for different NTM and NDT concepts industry.
<b>CO4:</b>	Evaluate appropriate NTM and non-destructive techniques.

<b>Reference Books:</b>	
1	Non Traditional 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.

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
<b>Introduction to general theory of elasticity:</b> 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
<b>Introduction to analysis of strain,</b> 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
<b>Theories of Failure and Energy Methods:</b> 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), Prandtl-Reuss theory, Saint venant – Von mises equations.		
<b>Principle of Superposition,</b> 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
<b>Bending of Beams:</b> 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
<b>Torsion:</b> 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
<b>Exercises:</b> <ol style="list-style-type: none"> <li>1. Basic Stress analysis</li> <li>2. Deflection and Stress Analysis in beams</li> <li>3. Nonlinear plastic Deformation and buckling Analysis</li> <li>4. Two dimensional problems (Plane stress &amp; Plane strain problems)</li> <li>5. Analysis of Composite materials</li> <li>6. Analysis of pressure vessels</li> <li>7. Three dimensional FE analysis</li> </ol>		



<b>Course Outcomes:</b> <b>After going through this course the student will be able to:</b>	
<b>CO1:</b>	Identify the stress-strain relations in elastic and plastic conditions
<b>CO2:</b>	Examine bodies subjected to three dimensional stresses for the onset of failure based on failure criteria.
<b>CO3:</b>	Analyze deflections in beams subjected to different types of loads for elastic, elastoplastic and plastic conditions
<b>CO4:</b>	Evaluate stresses in bars subjected to torsion for elastic, elastoplastic and plastic conditions

<b>Reference Books:</b>	
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., 1 <sup>st</sup> 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
<b>Review of Mechanical Vibrations:</b> 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
<b>Vibration Control:</b> 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, Vibration exciters, Signal analysis.					
Unit – III					08 Hrs
<b>Modal analysis:</b> Dynamic Testing of machines and Structures, Experimental Modal analysis.					
<b>Vibrations of beams:</b> 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.					
<b>Vibrations of plates:</b> equations of motion, modal analysis, approximate methods					
Unit – IV					08 Hrs
<b>Random Vibrations :</b> 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
<b>Signature analysis</b> and preventive maintenance, Vibration testing equipment, signal generation, measuring and conditioning instruments.					
<b>Vibration testing equipment:</b> 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

**Scheme of 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**

**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+26T		SEE Duration	:	3 Hrs

Unit – I	
<b>Overview of Research:</b> 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.	<b>07 Hrs</b>
Unit – II	
<b>Data and data collection:</b> Overview of probability and data types. Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. <b>Sampling Methods:</b> Probability sampling and Non-probability sampling	<b>08 Hrs</b>
Unit – III	
<b>Processing and analysis of Data:</b> Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools	<b>07 Hrs</b>
Unit – IV	
<b>Advanced statistical analyses:</b> Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.	<b>07 Hrs</b>
Unit – V	
<b>Essentials of Report writing and Ethical issues:</b> Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Ethical issues related to Research, Publishing, Plagiarism <b>Case studies:</b> Discussion of case studies specific to the domain area of specialization	<b>07 Hrs</b>

Course Outcomes:	
After going through this course the student will be able to:	
<b>CO1</b>	Explain the principles and concepts of research types, data types and analysis procedures.
<b>CO2</b>	Apply appropriate method for data collection and analyze the data using statistical principles.
<b>CO3</b>	Present research output in a structured report as per the technical and ethical standards.
<b>CO4</b>	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, 3 <sup>rd</sup> 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					
<div>1. Each project group will consist of maximum of two students.</div> <div>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.</div> <div>3. Allocation of the guides preferably in accordance with the expertise of the faculty.</div> <div>4. The number of projects that a faculty can guide would be limited to four.</div> <div>5. The minor project would be performed in-house.</div> <div>6. The implementation of the project must be preferably carried out using the resources available in the department/college.</div>					
<b>Course Outcomes:</b> <b>After going through this course the students will be able to</b> 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 (Professional Elective-C)						
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
<b>General Introduction:</b> 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
<b>Classical Theory Of Plates:</b> 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
<b>Buckling Analysis of Rectangular Plates:</b> 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
<b>Vibration of Plates:</b> 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
<b>Analysis of Thin Elastic Shells of Revolution:</b> 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, plate and 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 (Professional Elective-C)						
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
<b>Introduction to Design for Manufacture &amp; Assembly:</b> Steps in DFMA, Advantages of DFMA, Design guidelines for Manual Assembly and High-Speed Automatic and Robotic Assembly.					
<b>Geometrical Dimensioning &amp; Tolerance</b> – 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
<b>Metal Casting Processes – Gravity Die Casting :</b> 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, <b>Pressure Die Casting:</b> 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
<b>Design for Injection Molding</b> – 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
<b>Design for Powder Metallurgy Processes:</b> 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
<b>Design for Sheet Metal Processing:</b> 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. <b>Cost Estimation</b> 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 (Professional Elective-C)						
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
<b>Points, lines and planar curves:</b> Vector algebra <b>Shapes inside a computer:</b> 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
<b>Lines in space:</b> 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 <b>Transformations:</b> 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
<b>Combining transformations:</b> 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 homogeneous vectors <b>Useful manoeuvres:</b> Non-standard rotations and reflections the viewing transformation: Standard and standard, Rotation about an arbitrary point, Reflection in an arbitrary line, The viewing transformation <b>The third dimension:</b> 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
<b>Points of view:</b> 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 <b>A greater sense of perspective:</b> 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 <b>Space curves and surfaces:</b> 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 <b>Slopes of space curves:</b> 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
<b>Curve fitting:</b> Interpolation and shape function: Lines and curves from real objects, Linear interpolation, Quadratic interpolation, Uniqueness <b>Planes and surfaces:</b> 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 plane, 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)**

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 MACHINE DESIGN (Professional Elective-D)						
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
<b>Introduction:</b> 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. <b>Fatigue of Materials:</b> 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
<b>Stress-Life (S-N) Approach:</b> 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. <b>Strain-Life(<math>\epsilon</math>-N) approach:</b> 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 $\epsilon$ -N approach.		
Unit – III		11 Hrs
<b>LEFM Approach:</b> LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. <b>Notches and their effects:</b> 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
<b>Fatigue from Variable Amplitude Loading:</b> 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
<b>Surface Failure:</b> 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

**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						
ROBOTICS & AUTOMATION (Professional Elective-D)						
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
<b>Automation and Robotics</b> - 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
<b>Kinematics of Robot Manipulator:</b> 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
<b>Robotic Workspace &amp; Motion Trajectory:</b> 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
<b>Dynamics of Robotic Manipulators:</b> 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
<b>Autonomous Robot:</b> 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

**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 FINITE ELEMENT ANALYSIS (Professional Elective-D)						
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
<b>Basics of Finite Element Analysis :</b> 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 serindipidy 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
<b>Axisymmetric Solids:</b> 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
<b>Part 3: General Solids:</b> 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
<b>Dynamic Analysis using Finite Element Method:</b> 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
<b>Applications in Heat Transfer &amp; Fluid Mechanics:</b> 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

**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					
BUSINESS ANALYTICS (Global Elective-G01)					
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
<b>Business analytics</b> 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
<b>Trendiness and Regression Analysis</b> 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
<b>Organization Structures of Business analytics</b> 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
<b>Forecasting Techniques</b> 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
<b>Decision Analysis</b> Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.					
<b>Course Outcomes</b> <b>After going through this course the student will be able to:</b>					
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				
<b>Reference Books</b>					
1	Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1 <sup>st</sup> 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:10.1002/9781118983881,1 <sup>st</sup> Edition 2014				
3	Business Analytics, James Evans, Pearsons Education 2 <sup>nd</sup> Edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824				
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley: 1 <sup>st</sup> Edition, 2013.				

**Scheme of 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**

**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 AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)					
Course Code	:	18CV2G02		CIE	: 100 Marks
Credits L: T: P	:	3:0:0		SEE	: 100 Marks
Hours	:	39L		SEE Duration	: 3 Hrs
UNIT – I					7 Hrs
<b>Industrial safety:</b> 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 firefighting, equipment and methods.					
UNIT – II					9 Hrs
<b>Occupational health and safety:</b> 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					9 Hrs
<b>Hazardous Materials characteristics and effects on health:</b> 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					7 Hrs
<b>Wear and Corrosion and their prevention:</b> 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					7 Hrs
<b>Periodic and preventive maintenance:</b> 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.					
<b>Course Outcomes</b> After successful completion of 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.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009, S. Chand and Company, New Delhi, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALI, Second edition, 2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

**Scheme of 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. The 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) mini 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 (Global Elective-G03)						
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
<b>Linear Programming:</b> Introduction to Linear Programming problem						
<b>Simplex methods:</b> Variants of Simplex Algorithm – Use of Artificial Variables						
Unit – II						08 Hrs
<b>Advanced Linear Programming :</b> Two Phase simplex techniques, Revised simplex method						
<b>Duality:</b> Primal-Dual relationships, Economic interpretation of duality						
Unit – III						08 Hrs
<b>Sensitivity Analysis:</b> Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality						
Unit – IV						08 Hrs
<b>Transportation Problem:</b> 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
<b>Assignment Problem:</b> Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).						
<b>Course Outcomes</b>						
<b>After going through this course the student will be able to:</b>						
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.					
<b>Reference Books</b>						
1	Operation Research An Introduction, Taha H A, 8 <sup>th</sup> Edition, 2009, PHI, ISBN: 0130488089.					
2	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg - John 2 <sup>nd</sup> Edition, 2000, Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-81-265-1256-0					
3	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 9 <sup>th</sup> Edition, 2012, Tata McGraw Hill ISBN 13: 978-0-07-133346-7					
4	Operations Research Theory and Application, J K Sharma, 4 <sup>th</sup> Edition, 2009, Pearson Education Pvt Ltd, ISBN 13: 978-0-23-063885-3.					

**Scheme of 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. The 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) mini 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 (Global Elective-G04)						
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, 8 <sup>th</sup> Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.					
2	A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute, 5 <sup>th</sup> Edition, 2013, ISBN: 978-1-935589-67-9					
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 11 <sup>th</sup> Edition, 2013, John Wiley & Sons Inc., ISBN 978-1-118-02227-6.					
4	Project Management – Planning and Controlling Techniques, Rory Burke, 4 <sup>th</sup> Edition, 2004, John Wiley & Sons, ISBN: 9812-53-121-1					

**Scheme of 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. The 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) mini 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 (Global Elective-G05)					
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
<b>Energy conservation:</b> 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
<b>Wet Biomass Gasifiers:</b> 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
<b>Dry Biomass Gasifiers :</b> 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					08Hrs
<b>Solar Photovoltaic:</b> Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication.					
<b>Wind Energy:</b> Classification, Factors influencing wind, WECS & classification.					
Unit –V					07 Hrs
<b>Alternative liquid fuels:</b> 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.					
<b>Course Outcomes</b> <b>After successful completion of this course the student will be able to:</b>					
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				
<b>Reference Books</b>					
1	Nonconventional energy, Ashok V Desai, 5 <sup>th</sup> 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, 1 <sup>st</sup> Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.				
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2 <sup>nd</sup> Edition, 2009, Prentice Hall of India, ISBN: 9788120343863.				

**Scheme of 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.**

**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 (Global Elective-G06)						
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.
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**Scheme of 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**

**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 (Global Elective-G07)						
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 Editionmmm 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					

**Scheme of 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**

**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 (Global Elective-08)						
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
<b>Introduction to composite materials</b> 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
<b>Polymer matrix composites ( PMC)</b> 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
<b>Ceramic matrix composites and special composites</b> 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
<b>Metal matrix composites</b> 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
<b>Polymer nano composites</b> 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,						

Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nanocomposites.	
<b>Course Outcomes</b> <b>After completing the course, the students will be able to:</b>	
<b>CO1</b>	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
<b>CO2</b>	Identify the basic constituents of a composite materials and list the choice of materials available
<b>CO3</b>	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
<b>CO4</b>	Get insight to the possibility of replacing the existing macro materials with nano-materials
<b>Reference Books</b>	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3 <sup>rd</sup> Edition Springer-verlag Gmbh,2012 , ISBN: 978-0387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6 <sup>th</sup> Edition- Cengage, Publishers,2013, ISBN: 13: 978-8131516416
3	Polymer Science and Technology, Joel R Fried , 2 <sup>nd</sup> Edition, Prentice Hall, 2014, ISBN: 13: 978-0137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2 <sup>nd</sup> Edition, CRC Press-Taylor & Francis, 2010, ISBN: 10-9781498761666, 1498761666

**Scheme of 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**

**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 (Global Elective-09)						
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
<b>Crystal Structure</b> 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
<b>Dielectric Materials</b> 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, Piezoelectricity in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.						
Unit – III						08 Hrs
<b>Magnetic Materials</b> Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetism, 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
<b>Semiconducting Materials</b> 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
<b>Novel Materials</b> Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoe leasticity, Transformation hysteresis, Super elasticity, Characterization technique-Differential 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.						
<b>Course Outcomes</b> 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.					
<b>Reference Books</b>						
1.	Solid State Physics, S O Pillai, 6 <sup>th</sup> Edition, New Age International Publishers, ISBN 10-8122436978.					
2.	Introduction to Solid State Physics, C.Kittel, 7 <sup>th</sup> Edition, 2003, John Wiley & Sons, ISBN 9971-51-780780					

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, 6 <sup>th</sup> Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

**Scheme of 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 STATISTICAL METHODS (Global Elective-G10)						
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.						
<b>Course Outcomes</b>						
<b>After going through this course the student will be able to:</b>						
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	Analyse 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.					
<b>Reference Books</b>						
1.	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3 <sup>rd</sup> Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.					
2.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6 <sup>th</sup> Edition, John Wiley & Sons, 2014, ISBN:13 9781118539712, ISBN (BRV):9781118645062.					
3.	Fundamentals of Mathematical Statistic-A Modern Approach, S.C. Gupta and V.K. Kapoor, 10 <sup>th</sup> Edition, 2000, S Chand Publications, ISBN: 81-7014-791-3.					
4.	Regression Analysis: Concepts and Applications, F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press. ISBN-13: 978-0534198695.					

**Scheme of 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.

# **SYLLABUS FOR SEMESTER III & IV**

SEMESTER: III						
FRACTURE MECHANICS (Theory)						
Course Code	:	18MMD31		CIE Marks	:	100
Credits L: T: P	:	4:1:0		SEE Marks	:	100
Hours	:	52L+26T		SEE Duration	:	3 Hrs
Unit – I						10 Hrs
<b>Introduction:</b> The Fracture Mechanics Approach to Design, Early Fracture Research, Historical Perspective The Liberty Ships, Post-War Fracture Mechanics Research, , The Energy Criterion, The Stress-Intensity Approach, Time-Dependent Crack Growth and Damage Tolerance, Effect of Material Properties on Fracture, A Brief Review of Dimensional Analysis.						
<b>Linear Elastic Fracture Mechanics,</b> An Atomic View of Fracture, Stress Concentration Effect of Flaws, The Griffith Energy Balance, Comparison with the Critical Stress Criterion, Modified Griffith Equation, The Energy Release Rate, Instability and the R-Curve, Reasons for the R-Curve Shape, Load Control vs. Displacement Control, Structures with Finite Compliance, Stress Analysis of Cracks, The Stress Intensity Factor, Relationship between K and Global Behaviour, Effect of Finite Size , Principle of Superposition, Weight Functions, Relationship between K and G						
Unit – II						10 Hrs
<b>Crack-Tip Plasticity:</b> The Irwin Approach, The Strip-Yield Model, Comparison of Plastic Zone Corrections, Plastic Zone Shape, K -Controlled Fracture, Plane Strain Fracture: Fact vs. Fiction, Crack tip Triaxiality, Effect of Thickness on Apparent Fracture Toughness, Plastic Zone Effects, Implications for Cracks in Structures.						
<b>Mixed-Mode Fracture:</b> Propagation of an Angled Crack, Equivalent Mode I Crack, Bi-axial Loading Interaction of Multiple Cracks, Coplanar Cracks, Parallel Cracks. Mathematical Foundations of Linear Elastic Fracture Mechanics, Plane Elasticity, Cartesian Coordinates, Polar Coordinates, Crack Growth Instability Analysis, Crack-Tip Stress Analysis, Generalized In-Plane Loading, The Westergaard Stress Function.						
Unit – III						10 Hrs
<b>Elastic-Plastic Fracture Mechanics:</b> Crack-Tip-Opening Displacement, The Contour Integral, J as a Path-Independent Line Integral , J as a Stress Intensity Parameter , The Large Strain Zone , Laboratory Measurement of J , Relationships Between J and CTOD, Crack-Growth Resistance Curves, Stable and Unstable Crack Growth, Computing J for a Growing Crack, J-Controlled Fracture.						
<b>Dynamic and Time Dependent Fracture:</b> Dynamic Fracture and Crack Arrest, Rapid Loading of a stationary crack, Rapid Crack Propagation and Arrest, Crack Speed, Elastodynamic crack-tip parameters, Dynamic Toughness, Crack Arrest, Dynamic Contour Integrals						
Unit – IV						12 Hrs
<b>Application to Structures:</b> $K_I$ for Part-Through cracks, influence coefficients for polynomial stress distributions, weight functions for arbitrary loading, primary, secondary and residual stresses. CTOD design curve, Failure Assessment Diagrams (FAD), original concept, J-based FAD, application to welded structures, incorporating weld residual stresses, weld misalignment, weld strength mismatch. Primary vs. Secondary stresses in FAD Method, Ductile-tearing Analysis with FAD.						
<b>Fatigue Crack Propagation,</b> Similitude in Fatigue, Empirical Fatigue Crack Growth Equations, Crack Closure , A Closer Look at Crack-Wedging Mechanisms, Effects of Loading Variables on Closure, The Fatigue Threshold, The Closure Model for the Threshold, A Two-Criterion Model, Threshold Behaviour in Inert Environments, Variable Amplitude Loading and Retardation, Linear Damage Model for Variable Amplitude Fatigue, Reverse Plasticity at the Crack Tip, The Effect of Overloads and Under loads , Models for Retardation and Variable Amplitude Fatigue.						



Unit –V		10 Hrs
<b>Fracture Testing of Metals &amp; Non-Metals:</b> General Considerations, specimen configurations, Specimen orientation, Fatigue Precracking, Instrumentation, Side grooving, $K_{IC}$ testing, ASTM E399, K-R Curve Testing, Specimen design, experimental measurement of K-R curves, J-testing of metals, CTOD testing, Fracture testing of weldments. Fracture Toughness Measurements in Engineering Plastics, $K_{IC}$ Testing, J-Testing, Qualitative Fracture Tests on Plastics.		
<b>Computational Fracture Mechanics,</b> Overview of Numerical Methods, The Finite Element Method, The Boundary Integral Equation Method, Traditional Methods in Computational Fracture Mechanics, Stress and Displacement Matching, Elemental Crack Advance, Contour Integration, Virtual Crack Extension: Stiffness Derivative Formulation, Virtual Crack Extension: Continuum Approach.		
<b>Course Outcomes</b> <b>After going through this course the student will be able to:</b> CO1: Demonstrate the material failure for any combination of applied stresses CO2: Ability to Assess the failure conditions of a structure CO3: Determine the stress intensity factor for simple components of simple geometry CO4: To conduct fracture testing of metals & non-metals and learn computational fracture mechanics using FEM		
<b>Reference Books:</b>		
1	FractureMechanics: Fundamentals and Applications, T. L. Anderson, Taylor and Francis Fourth Edition, 2005. ISBN: 977-3-735689-37-8	
2	Elementary Engineering Fracture Mechanics, David Broek, Kluwer Academic Publishers, 4 <sup>th</sup> revised Edition. ISBN: 978-1-935159-47-9	
3	Elements of Fracture Mechanics, Prashanth Kumar, Tata McGraw-Hill Education, 2009 ISBN: 077-1-732682-17-2	
4	Fracture Mechanics, E.E. Gdoutos, Kluwer Academic Publishing, Boston, 1993. ISBN: 947-1-272683-32-9	

### Scheme of 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: III						
INTERNSHIP						
Course Code	:	18MMD32		CIE Marks	:	100
Credits L:T:P	:	0:0:5		SEE Marks	:	100
Hours/week	:	10		SEE Duration	:	3 Hrs
GUIDELINES						
<div>1) The duration of the internship shall be for a period of 8 weeks on full time basis after II semester final exams and before the commencement of III semester.</div> <div>2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.</div> <div>3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.</div> <div>4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.</div> <div>5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry / organizations.</div> <div>6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.</div> <div>7) The broad format of the internship final report shall be as follows<ul style="list-style-type: none"><li>Cover Page</li><li>Certificate from College</li><li>Certificate from Industry / Organization</li><li>Acknowledgement</li><li>Synopsis</li><li>Table of Contents</li><li>Chapter 1 - Profile of the Organization : Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,</li><li>Chapter 2 -Activities of the Department</li><li>Chapter 3 - Tasks Performed : summaries the tasks performed during 8 week period</li><li>Chapter 4 – Reflections : Highlight specific technical and soft skills that you acquired during internship</li><li>References &amp; Annexure</li></ul></div>						
<b>Course Outcomes</b> <b>After going through the internship the student will be able to:</b> CO1: Apply engineering and management principles CO2: Analyze real-time problems and suggest alternate solutions CO3: Communicate effectively and work in teams CO4: Imbibe the practice of professional ethics and need for lifelong learning.						
<b>Scheme of Continuous Internal Evaluation (CIE):</b> The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.						

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainability presentation skills and report writing	55%

**Scheme for Semester End Evaluation (SEE):**

The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER: III						
MAJOR PROJECT: PHASE-I						
Course Code	:	18MMD33		CIE Marks	:	100
Credits L:T:P	:	0:0:5		SEE Marks	:	100
Hours/week	:	10		SEE Duration	:	3 Hrs
GUIDELINES						
7. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.						
8. The total duration of the Major project Phase-I shall be for 16 weeks.						
9. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.						
10. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.						
11. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.						
12. Students have to complete Major Project Phase-I before starting Major Project Phase-II.						
13. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.						
Course Outcomes						
After going through this course the students will be able to:						
CO5: Conceptualize, design and implement solutions for specific problems.						
CO6: Communicate the solutions through presentations and technical reports.						
CO7: Apply project and resource managements skills, professional ethics, societal concerns						
CO8: Synthesize self-learning, sustainable solutions and demonstrate life-long learning						

**Scheme of Continuous Internal Examination (CIE)**

Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of the topic, Literature Survey, Problem Formulation and Objectives	45%
Review-II	Methodology and Report writing	55%

**Scheme for Semester End Evaluation (SEE):**

Major Project Phase-I evaluation shall be done by an external examiner (domain expert) and respective guide as per the schedule. Maximum of four candidates per batch shall be allowed to take examination. The batches are to be formed based on specific domain of work.

SEMESTER: III						
MECHATRONICS SYSTEM DESIGN (Professional Elective-E1)						
Course Code	:	18MMD3E1		CIE Marks	:	100
CreditsL:T:P	:	4:0:0		SEE Marks	:	100
Hours	:	52L		SEE Duration	:	3 Hrs
Unit – I						10 Hrs
<b>Introduction:</b> Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Design of Mechatronics system Objectives, advantages and disadvantages of Mechatronics.						
<b>Transducers and sensors:</b> Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, proximity switches and Hall effect sensors.						
Unit – II						10 Hrs
<b>Microprocessor &amp; Microcontrollers:</b> Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.						
<b>Microprocessor Architecture:</b> Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data, Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel’s 8086A Microprocessor.						
Unit – III						10 Hrs
<b>Programmable logic controller:</b> Introduction to PLC’s, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching & selection of a PLC						
<b>Integration:</b> Introduction & background, Advanced actuators, Pneumatic actuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot.						
Unit – IV						10 Hrs
<b>Mechanical actuation systems:</b> Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, belt and chain drives, mechanical aspects of motor selection.						
<b>Electrical actuation systems:</b> Electrical systems, Mechanical switches, Solenoids, Relays, DC/AC Motors, Principle of Stepper Motors & servo motors.						
Unit – V						12 Hrs
<b>Pneumatic and hydraulic actuation systems:</b> Actuating systems, Pneumatic and hydraulic systems, Classifications of Valves, Pressure relief valves, Pressure regulating/reducing valves, Pressure sequence valve, Cylinders and rotary actuators.						
<b>DCV &amp; FCV-</b> Principle & construction details, types of sliding spool valve, solenoid operated, Symbols of hydraulic elements, components of the hydraulic system, functions of various units of hydraulic system. Design of simple hydraulic circuits for various applications.						
<b>Course Outcomes</b> <b>After going through this course the student will be able to:</b> CO1: Define and illustrate the various components of Mechatronics system. CO2:Identify, Categorize and apply transducers and sensors used in automation, control system and instruments CO3: Assess various control systems used in automation. CO4: Develop mechanical, hydraulic, pneumatic and electrical based circuit systems.						
<b>Reference Books:</b>						
1.	Mechatronics-Principles, Concepts and Applications, NitaigourPremchandMahalik, Tata McGraw Hill, 1 <sup>st</sup> Edition, 2003, ISBN No. 0071239243.					
2.	Mechatronics by HMT Ltd., Tata McGraw Hill, 1 <sup>st</sup> Edition, 2000, ISBN No. 9780074636435.					

3.	Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education, 1 <sup>st</sup> Edition, 2005, ISBN No.81-7758-284-4.
4.	Fluid Power, Anthony Esposito, Pearson Education-Sixth Edition-2011, ISBN N0:9789332518544

**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.**

**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: III						
SURFACE ENGINEERING (Professional Elective-E2)						
Course Code	:	18MPD3E2		CIE Marks	:	100
Credits L:T:P	:	4:0:0		SEE Marks	:	100
Hours	:	52L		SEE Duration	:	3 Hrs
Unit – I						10 Hrs
Introduction Tribology, surface degradation, wear and corrosion, types of wear, roles of friction and lubrication- overview of different forms of corrosion, introduction to surface engineering, importance of substrate						
Unit – II						10 Hrs
Chemical and electrochemical polishing, significance, specific examples, chemical conversion coatings, phosphate, chromating, chemical coloring, anodizing of aluminum alloys, thermo chemical processes - industrial practices						
Unit – III						11 Hrs
Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices, alloy plating, electro composite plating, electroless plating of copper, nickel phosphorous, nickel-boron; electroless composite plating; application areas, properties, test standards (ASTM) for assessment of quality deposits.						
Unit – IV						11Hrs
Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD, specific industrial applications						
Unit – V						10 Hrs
Thermal spraying, techniques, advanced spraying techniques - plasma surfacing, D-Gun and high velocity oxy-fuel processes, laser surface alloying and cladding, specific industrial applications, tests for assessment of wear and corrosion behavior.						
<b>Course Outcomes</b> <b>After going through this course the student will be able to:</b> CO1: Explain various forms of corrosion and basic concepts of surface engineering CO2: Evaluate the different surface engineering processes with respect to industrial practices CO3: Apply the knowledge of different spraying techniques in surface engineering CO4: Analyze tests for assessment of wear and corrosion behavior.						
<b>Reference Books</b>						
1	Surface modification technologies - An Engineer’s guide, Sudarshan T S, Marcel Dekker, Newyork, 1989, ISBN: 781560327127.					
2	Electroplating and Other Surface Treatments - A Practical Guide, Varghese C.D, TMH, 1993, ISBN: 0871707055					
3	Surface Engineering Practice, Strafford, K.N., Datta, P.K., and Gray, J.S., Processes, Fundamentals and Applications in Corrosion and Wear, Ellis Harwood (1990). , ISBN: 1351412574, 9781351412575					
4	Advanced Surface Coatings: A Hand book of Surface Engineering, Mathews, A., Spinger (1991). ISBN:9780216928992					

**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.**

**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: III						
EXPERIMENTAL MECHANICS (Professional Elective-E3)						
Course Code	:	18MMD3E3		CIE Marks	:	100
Credits L:T:P	:	4:0:0		SEE Marks	:	100
Credits	:	52L		SEE Duration	:	3 Hrs
Unit-I						10 Hrs
<b>Introduction:</b> Definition of terms, calibration, standards, dimensions and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.						
<b>Analysis of Experimental Data:</b> Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, Gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis.						
Unit-II						12 Hrs
<b>Data Acquisition and Processing:</b> General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.						
<b>Force, Torque and Strain Measurement:</b> Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.						
Unit-III						10 Hrs
<b>Photoelastic Stress Analysis:</b> Two Dimensional Photo elasticity - Nature of light, - wave theory of light - optical interference - Polariscopes Stress-optic law- effect of stressed model in plane and circular Polariscopes.						
<b>Isoclinic Iso chromatics fringe orderdetermination</b> – Fringe multiplication techniques - Calibration of Photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling.						
Unit-IV						10 Hrs
<b>Three Dimensional Photo elasticity:</b> Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principles, Polari scope and stress data analyses.						
<b>Coating Methods:</b> Photoelastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photoelastic strain gauges. Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques.						
Unit-V						10 Hrs
<b>Moiré Technique</b> - Geometrical approach, Displacement approach- sensitivity of moiré data reduction, In plane and out plane moiré methods, Moiré photography, moiré grid production.						
<b>Holography:</b> Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holographic interferometry, Real-time and double exposure methods, Displacement measurement. Isopachics.						

**Course Outcomes**

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

CO1: Understand experimental investigations to verify predictions by other methods.

CO2: Ability to acquire skills for experimental investigations

CO3: To provide a detailed knowledge of modern full field techniques such as Photoelastic Stress Analysis (PSA), Three-Dimensional Photo elasticity (TDP)

CO4: Explain different types of coatings, test strain data using brittle coating and birefringent coating & holographic techniques

**Reference Books:**

1	Experimental Methods for Engineers, Holman, 7 <sup>th</sup> Edition, Tata McGraw-Hill Companies, Inc, New York, 2007
2	Mechanical measurements, R. S. Sirohi, H. C. Radha Krishna, New Age International Pvt. Ltd., New Delhi, 2004
3	Experimental Stress Analysis, Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra, Pant, Tata McGraw Hill, 1984.
4	Instrumentation, Measurement And Analysis, Nakra & Chaudhry, B C Nakra K K Chaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

**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.**

**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: IV					
MAJOR PROJECT: PHASE-II					
Course Code	:	18MMD41		CIE Marks	: 100
Credits L:T:P	:	0:0:20		SEE Marks	: 100
Hours/Week	:	40		SEE Duration	: 3 Hrs
GUIDELINES					
<div>1. Major Project Phase-II is continuation of Phase-I.</div> <div>2. The duration of the Phase-II shall be of 16 weeks.</div> <div>3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.</div> <div>4. It is mandatory for the student to present/publish the work in National/International conferences or Journals</div> <div>5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.</div>					
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 project and resource managements skills, professional ethics, societal concerns					
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning.					

#### Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Review and refinement of Objectives, Methodology and Implementation	20%
Review-II	Design, Implementation and Testing	40%
Review-III	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40%

#### Scheme for Semester End Evaluation (SEE):

Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report and CIE marks.

#### Stage-1 Report Evaluation

Evaluation of Project Report shall be done by guide and an external examiner.

#### Stage-2 Project Viva-voce

Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats.

SEE procedure is as follows:

	Internal Guide	External Examiner	TOTAL	
SEE Report Evaluation	100 marks	100 marks	200 marks	
			(A)	(200/2) = 100 marks
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator		(B)	100 marks
Total Marks				[(A)+(B)]/2 = 100

SEMESTER: IV						
TECHNICAL SEMINAR						
Course Code	:	18MMD42		CIE Marks	:	50
Credits L:T:P	:	0:0:2		SEE Marks	:	50
Hours/Week	:	4		SEE Duration	:	30 Mins
GUIDELINES						
1. The presentation shall be done by individual students.						
2. The seminar topic shall be in the thrust areas of respective PG programs						
3. The seminar topic could be complementary to the major project work						
4. The student shall bring out the technological developments with sustainability and societal relevance.						
5. Each student must submit both hard and soft copies of the presentation along with the report.						
6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.						
Course Outcomes						
After going through this course the student will be able to:						
CO1	Identify topics that are relevant to the present context of the world					
CO2	Perform survey and review relevant information to the field of study.					
CO3	Enhance presentation skills and report writing skills.					
CO4	Develop alternative solutions which are sustainable					

**Scheme of Continuous Internal Evaluation (CIE):** Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of Topic, Review of literature, Technical Relevance, Sustainability and Societal Concerns, Presentation Skills	45%
Review-II	Technological Developments, Key Competitors, Report writing	55%

**Scheme for Semester End Evaluation (SEE):**

The SEE examination shall be conducted by an external examiner and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.