RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R. V. Vidyaniketan Post, Mysuru Road

Bengaluru – 560 059

Scheme and Syllabus of I & II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

COMPUTER INTEGRATED MANUFACTURING

DEPARTMENT OF

MECHANICAL ENGINEERING

INNER FRONT COVER PAGE

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

RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysuru Road

Bengaluru – 560 059

Scheme and Syllabus of I & II Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

COMPUTER INTEGRATED MANUFACTURING

DEPARTMENT OF

MECHANICAL ENGINEERING

VISION

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

MISSION

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

Program Outcomes (PO)

M. Tech. in Computer Integrated Manufacturing graduates will be able to:

PO1: An ability to independently carry out a research / investigation and development work to solve practical problems related to Computer Integrated Manufacturing

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 Computer Integrated Manufacturing. The mastery should be at a level higher than the requirements in the BE Mechanical Engineering and allied programs

PO4: An ability to use latest technology for the design and analysis of CNC based manufacturing and automation systems

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

PO6: An ability to perform interdisciplinary teams with social and management skills with a commitment to lifelong learning

ABBREVIATIONS

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

INDEX

RV COLLEGE OF ENGINEERNG®, BENGALURU-560 059
(Autonomous Institution Affiliated to VTU, Belagavi)
DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech in Computer Integrated Manufacturing

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MAT11A	Applied Mathematics	MAT	4	0	0	**4**
2	18MCM 12	Computer Control of Manufacturing Systems	ME	3	1	1	**5**
3	18MPD13	Finite Element Analysis	ME	4	0	1	**5**
4	18HSS14	Professional Skills Development	HSS	0	0	0	**0**
5	18XXX 1AX	Elective A	ME	3	1	0	**4**
6	18XXX1BX	Elective B	ME/CSE	4	0	0	**4**
Total number of Credits				**18**	**02**	**02**	**22**
Total Number of Hours / Week							

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MCM21	Mechatronics in Manufacturing Systems	ME	4	0	1	**5**
2	18MCM22	Tooling for Manufacturing in Automation	ME	3	1	0	**4**
3	18IM23	Research Methodology	IEM	3	0	0	**3**
4	18MCM24	Minor Project	ME	0	0	2	**2**
5	18XXX2CX	Elective C	ME	4	0	0	**4**
6	18XXX2DX	Elective D	ME	4	0	0	**4**
7	18XXX2GXX	Global Elective	Respective Boards	3	0	0	**3**
Total number of Credits				**21**	**01**	**03**	**25**
Total Number of Hours / Week							

I Semester		
GROUP A: CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18 MPD 1A1	Product Design for Quality
2.	18 MMD 1A2	Tribology
3.	18 MCM 1A3	Design of Hydraulic & Pneumatic Systems
GROUP B: CORE ELECTIVES		
1.	18 MPD1B1	Product Data Management
2.	18 MCE1B2	Intelligent Systems
3.	18 MCM 1B3	Non-Traditional Machining & Testing
II Semester		
GROUP C: CORE ELECTIVES		
1.	18 MCM 2C1	Automation and Production Systems
2.	18 MPD2C2	Design for Manufacture & Assembly
3.	18 MCM2C3	Computer Application in Design
GROUP D: CORE ELECTIVES		
1.	18 MCM2D1	Advanced Metrology
2.	18 MCM 2D2	Robotics & Automation
3.	18 IEM 2D3	Supply Chain Management

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

Semester: I						
APPLIED MATHEMATICS (Common to MPD,MMD,MCM,MPE,MBT,MBI,MCH,MST,MHT)						
Course Code	**:**	**18MAT11A**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**47L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Statistics: Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation.	**09 Hrs**
Unit – II	
Probability distributions: Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.	**09 Hrs**
Unit – III	
System of linear equations and eigen value problems: System of linear equations-LU decomposition and Gauss-Jordan method, Eigen value problems–bounds on eigen values, Power method and Inverse Power method, Eigen values and eigen vectors of real symmetric matrices-Jacobi method.	**09 Hrs**
Unit – IV	
Numerical solution of differential equations: Boundary value problems (BVP's)–finite difference method for linear and nonlinear problems, Shooting method and Galerkin method. Finite differences-implicit and explicit scheme, Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations, Finite element method and simple problems.	**10 Hrs**
Unit –V	
Engineering optimization: Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems.	**10 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various field engineering.
CO2	Apply the knowledge and skills of statistical/numerical/optimization techniques to solve problems of least squares, probability distributions, linear equations, eigen value problems and differential equations.
CO3	Analyze the physical problem to establish a statistical / mathematical model and use an appropriate method to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of least squares, probability distributions, linear equations, eigen value problems, differential equations and optimization arising in practical situations.

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

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 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						
COMPUTER CONTROL OF MANUFACTURING SYSTEMS (Theory & Practice)						
Course Code	**:**	**18MCM12**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**3:1:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
INTRODUCTION TO CNC MACHINE TOOLS: Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection	**07 Hrs**
Unit – II	
STRUCTURE OF CNC MACHINE TOOL: CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings. **DRIVES AND CONTROLS**: Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Axis measuring system – Resolver, gratings, moiré fringe gratings, encoders, laser interferometer.	**07 Hrs**
Unit – III	
NC and CNC systems: Advantages and limitations. CNC systems – Introduction, types, features on CNC machining and turning centers, advantages. Coordinate system in CNC machine tools, Machining Centers, Tooling for CNC machines. Interpolator for a CNC System: DDA integrator, hardware and software interpolator. **CNC part programming:** Steps involved in preparation of part programming, coding systems, basic categories of NC codes, preparatory and miscellaneous codes, programming functions.	**07 Hrs**
Unit – IV	
Turning center part programming: manual part programming for turning center, single and multi-pass canned cycles, and exercise problems on turning centers. **Machining center part programming:** Manual part programming for machining center, Cutter compensations: cutter radius compensation, tool length compensation and tool wear compensation. Drilling canned cycles, sub-programming, macros and simple exercise problems on machining centers.	**07 Hrs**
Unit –V	
Adaptive control systems: Elements of Adaptive control systems, Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining. **Fundamentals of Rapid Prototyping**: Benefits and Application, STL file Generation, Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling vs. RT, Need for RT. Rapid Prototyping Machines: Classification, Description of RP Machines: Stereo lithography, Selective Laser Sintering, Fused deposition modeling, laminated object manufacturing, Laser powder forming	**08 Hrs**
Unit- VI (Lab Component)	
Manual CNC Part Programming for Turning and Machining Centers - Manual CNC Part Programming Using Standard G and M Codes - Tool Path Simulation – Exposure to Various Standard Control Systems - Machining simple components by Using CNC machines Part programming for CNC Machines using CAM Packages, simulation of	**24P Hrs**

turning/drilling/milling operations.	

Course Outcomes: After going through this course the student will be able to:	
CO1	Describe fundamentals and concepts in CNC system
CO2	Analyze latest developments in CNC system
CO3	Apply design consideration for increasing productivity with CNC and RP
CO4	Develop manual part programs for complex profiles and test the programs through simulation.

Reference Books:	
1	M. Koren, Computer Controls of Manufacturing Systems, Tata McGraw-Hill Edition 2005 ISBN 0-07-060743-5
2	P.N. Rao, CAD/CAM Principles and Applications, Tata McGraw-Hill 2nd Edition, 2006. ISBN 10: 0070681937 / ISBN 13: 9780070681934.
3	P Radhakrishnan, Computer Numerical Control Machines and Computer Aided Manufacture, 1st Edition, 2012. ISBN: 9788122433975, 8122433979
4	Groover M P, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall India (P) Ltd, 3rd Edition. ISBN 10: 0133499618 ISBN 13: 9788120334182

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

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 is 20+50+30=100 Marks.

Scheme of Continuous Internal Evaluation (CIE) for 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.

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

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: I						
FINITE ELEMENT ANALYSIS (Theory & Practical)						
Course Code	**:**	**18MPD13**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Introduction: Need for numerical methods to solve engineering problems – mathematical modeling – discrete and continuum modeling - relevance and scope of finite element methods – engineering applications of FEA. Weighted residual methods – Rayleigh Ritz method –application to bar element and beam elements	**10 Hrs**
Unit – II	
One Dimensional Problems: Natural co-ordinates, Elemental equations for bar element, quadratic element, truss element, nodal approximation – development of shape functions – element matrices and vectors – example problems	**09 Hrs**
Unit – III	
Two Dimensional Problems : Three noded triangular elements – four noded rectangular elements – higher order elements – Lagrange approach - iso-parametric, super-parametric, sub-parametric elements	**09 Hrs**
Unit – IV	
Dynamic Problems: Formulation of dynamic problems, consistent and lumped mass matrices for bar and beam elements, evaluation of Eigenvalue and Eigen vector (characteristic polynomial technique) **Heat Transfer Problems:** 1-D element, steady state heat transfer, one dimensional heat conduction, one dimensional heat transfer in thin fins, problems	**10 Hrs**
Unit –V	
Finite element Modeling of Machining considerations: formulation, meshing, boundary conditions, material modeling, chip separation-chip breakage, high speed machining modeling, 3D machining modeling **Beams:** Finite element formulation, evaluation of shear force and bending moment for various loading conditions**,** problems	**10 Hrs**
Unit- VI (Lab Component)	
Part-I	
Introduction to ANSYS, element library, applicability for engineering analysis, analysis of bars, trusses, beams and shafts, static analysis of 2D plates – subject to plane load, bending load and shells with internal pressure	**12 Hrs**
Part-II	
Dynamic and Thermal Analysis – Normal modal analysis of beams, bars and truss elements, harmonic analysis of beam structures, conductive, convective and radiative heat transfer problems, coupled field analysis	**12 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Understand the fundamentals of finite element methods
CO2	Develop the knowledge to analyze structures in static and dynamic conditions
CO3	Assess the numerical techniques for solving engineering problems
CO4	Formulate finite element model to implement industrial projects

	Reference Books:
1	Hutton, Fundamentals of FEM, Tata McGraw Hill education Pvt. Ltd, 2005, ISBN: 0070601224
2	Daryl L Logan, First Course in Finite element methods, 5th Edition, Thomson Brooks, 2011, ISBN : 10:0495668257
3	T R Chandrupatla, A D Belegondu, Introduction to FE in engineering, 3rd Edition, Prentice Hall, 2004
4	Angelos.P. Markopoulos, Finite Element method in machining processes, Springer series, 2013, ISBN: 978-1-4471-4330-7

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

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 is 20+50+30=100 Marks.

Scheme of Continuous Internal Evaluation (CIE) for 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.

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

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: I						
PROFESSIONAL SKILL DEVELOPMENT (Common to all Programs)						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits:L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**18L**				

Unit – I	**03 Hrs**
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. **Resume Writing:** Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
Unit - II	**08 Hrs**
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. **Reasoning** – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification. **Analytical Reasoning** - Single & Multiple comparisons, Linear Sequencing. **Logical Aptitude** - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. **Verbal Analogies/Aptitude** – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving	
Unit - III	**03 Hrs**
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews	
Unit - IV	**02 Hrs**
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion(Assertiveness) and presentation skills	
Unit - V	**07 Hrs**
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). **Leadership Skills:** Ethics and Integrity, Goal Setting, leadership ability.	

Course Outcomes: After going through this course the student will be able to:	
CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

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

Scheme of Continuous Internal Examination (CIE)

Evaluation of CIE will be carried out in TWO Phases.

Phase	**Activity**
I	After 9 hours of training program, 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	Similarly students will have to take up another test after the completion 18 hours of training. 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%. Needless to say the attendance requirement will be the same as in any other course.	

Semester: I						
PRODUCT DESIGN FOR QUALITY (Group A: Core Elective)						
Course Code	**:**	**18MPD1A1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

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

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

Reference Books:	
1	Total quality Management Kevin Otto & Kristin Wood, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE), 2001. ISBN10: 0130212717
2	Karl T. Ulrich, Steven D. Eppinger, Product Design and Development, TATA McGraw-HILL-3rd Edition, 2003. ISBN:13: 978-0073404776
3	James R. Evens, William M Lindsay,"The Management and control of Quality"-6th edition- South-Western Publishers ISBN: 0314062157
4	George E Dieter, Engineering Design, 3rd 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 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 is 20+50+30=100 Marks.

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

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

Semester: I						
TRIBOLOGY (Group A: Core Elective)						
Course Code	**:**	**18MMD1A2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems	**06 Hrs**
Unit – II	
Hydrodynamic Lubrications: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems. **Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Somerfield number and its significance, partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.	**10 Hrs**
Unit – III	
Hydrostatic Bearings: Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.	**08 Hrs**
Unit – IV	
EHL Contacts: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution **Porous Bearings:** Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages.	**06 Hrs**
Unit –V	
Magnetic Bearings: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings	**06 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Demonstrate fundamentals of tribology, lubricants and methods of lubrication
CO2	Analyze bearings for load carrying capacity, frictional force and power loss
CO3	Illustrate the different modes of lubrication system for various applications.
CO4	Design the different bearing system such as antifriction bearings, magnetic bearings and porous bearings for various applications

Reference Books:	
1	Dudley D.Fuller, Theory and practice of Lubrication for Engineers, New YorkCompany.1998
2	Moore, Principles and applications of Tribology, Pergamon press, 1975

3	G W Stachowiak, A W Batchelor , Engineering Tribology, Elsevier publication 1993.
4	Radzimovsky, Lubrication of Bearings - Theoretical principles and design, 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 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 is 20+50+30=100 Marks.**

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

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

Semester: I						
DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS (Group A: Core Elective)						
Course Code	**:**	**18MCM1A3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction to Hydraulic System: Introduction, Basic hydraulic system, classification of hydraulic motors, hydraulic pumps, Performance of hydraulic motors, Hydraulic actuators, types of hydraulic actuators. **Control Components in Hydraulic Systems:** Introduction, Direction control valves, Solenoid actuated valve, Pilot operated valve, Rotary spool DCV, Pressure control valves, Hydraulic fuse, Flow control valve, graphic symbols.	**07 Hrs**
Unit – II	
Maintenance of Hydraulic Systems: Prime function of hydraulic fluids, desirable properties of hydraulic fluids, general types of fluids, factors affecting the selection of fluids, sealing devices, reservoir systems, filters and strainers, heat exchangers, pressure switch, wear of moving parts, troubleshooting of hydraulic systems.	**06 Hrs**
Unit – III	
Hydraulic circuit Design and Analysis: Control of a single acting cylinder, double acting cylinder, regenerative circuit, counter balance valve applications, Hydraulic cylinder sequencing circuits, automatic cylinder reciprocating systems, Locked cylinder using pilot check valves, cylinder synchronizing circuits, fail safe circuits.	**07 Hrs**
Unit – IV	
Pneumatic Concepts: Introduction, comparison of hydraulics/pneumatics/and electrical system, air compressor system, types of compressors, compressed air behavior, pneumatic actuators, direction control valves, building a pneumatic circuits, application of logic valves. **Design of Pneumatic Circuits:** Speed control circuits, Application of time delay valves. Position sensing in pneumatic cylinders, roller lever valve, pressure sensing in pneumatic circuits, pressure sequence valve, two cylinder movement,cascade method.	**08 Hrs**
Unit –V	
Electro-Pneumatics: Introduction, Pilot operated solenoid valve, Electrical connection to the solenoid, Electro-pneumatic circuit, Electrical limit switches and proximity switches, Relays, Solenoid, PE converter, Concept of latching. **Servo System and PLC Applications in Pneumatics**: Closed loop control with servo system, Hydro-mechanical servo system, Electro-hydraulic servo system, Conventional valve vs proportional valve, Proportional valve in hydraulic circuits, characteristics of proportional valve and servo valve. PLC application in fluid power, logic in ladder logic diagram and Mnemonics, Timer- on delay and off delay.	**08 Hrs**

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	S Ilango, V Soundararajan, Introduction to Hydraulics and Pneumatics, PHI Publication, ISBN-978-81-203-3079-5.
2	Jagadeesha T, Hydraulics and Pneumatics, I K International Publication, ISBN: 978-93-84588-90-8
3	James L Johnson, Introduction to fluid power, Cengage Learning, first edition 2003, ISBN- 981-243-661-8
4	R Srinivasan, Hydraulic and pneumatic controls, 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 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 is 20+50+30=100 Marks.

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

Semester: I						
PRODUCT DATA MANAGEMENT (Group B: Core Elective)						
Course Code	**:**	**18MPD1B1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
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	**10 Hrs**
Unit – II	
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	**10 Hrs**
Unit – III	
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	**10 Hrs**
Unit – IV	
Creating Product Structures: Part centric approach, CAD centric approach, Product Structure configuration, Managing Product Structures, PDM resources on the Internet.	**08 Hrs**
Unit –V	
PDM Implementation Case Studies: Matrix One, Team Center, Windchill, Enovia. Standards in PDM, CM, SCM and CMM.	**10 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Understanding the Product data base systems
CO2	Select the Product data base systems based on material and product
CO3	Analyzing the Product data base and Product life cycle for new products
CO4	Evaluate the parameters for Product data base considerations based on process

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

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 is 20+50+30=100 Marks.**

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

Semester: I						
INTELLIGENT SYSTEMS (Group B: Core Elective) (Common to CSE, MPD, MD, CIM)						
Course Code	**:**	**18MCE1B2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**46L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Overview of Artificial Intelligence: Artificial Intelligence and its Application areas; **Knowledge Representation and Search:** The Predicate Calculus :The Propositional Calculus, The Predicate Calculus, Using Inference Rules to Produce Predicate Calculus Expressions, Application: A Logic-Based Financial Advisor **Structures and strategies for state space search:** Introduction, Structures for state space search, Strategies for State Space Search, Using the State Space to Represent Reasoning with the Predicate Calculus; And/Or Graphs	**09 Hrs**
Unit – II	
Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, The Best-First Search Algorithm, Admissibility, Monotonicity and Informedness, Using Heuristics in Games, Complexity Issues. **Control and Implementation of State Space Search**: Introduction, Recursion-Based Search, Production Systems, The Blackboard Architecture for Problem Solving	**09 Hrs**
Unit – III	
Other Knowledge Representation Techniques: Semantic Networks, Conceptual Dependencies, Scripts and Frames, Conceptual Graphs **Knowledge Intensive Problem Solving:** Overview of Expert System Technology, Rule-Based Expert Systems, Model-Based, Case Based, and Hybrid Systems **Planning:** Introduction to Planning, Algorithms, as State-Space Search, Planning graphs.	**09 Hrs**
Unit – IV	
Automated Reasoning: Introduction to Weak Methods in Theorem Proving, The General Problem Solver and Difference Tables, Resolution Theorem Proving **Uncertain Knowledge and Reasoning** Introduction to Uncertainty, Inference using Full-Joint Distribution, Independence, Bayes' Rule and its use. **Representing Knowledge in Uncertain Domain:** Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Network, Approximate Inference in Bayesian Network	**10 Hrs**
Unit –V	
Introduction to Learning: Forms of Learning: Supervised learning, Unsupervised Learning, Semi-Supervised and Reinforcement Learning; Parametric Models & Non-Parametric Models, Classification and Regression problems **Artificial Neural Networks:** ANN Structures, Single Layer feed-forward neural networks, multilayer feed-forward neural networks, Learning in multilayer networks, networks. **Artificial Intelligence Current Trends:** The Science of Intelligent Systems, AI: Current Challenges and Future Directions	**09 Hrs**

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	Analyze and compare the relative challenges pertaining to design of Intelligent Systems

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

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 is 20+50+30=100 Marks.

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

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

Semester: I						
NON-TRADITIONAL MACHINING & TESTING (Group B: Core Elective)						
Course Code	**:**	**18MCM1B3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Need for unconventional machining processes, classification of non-traditional machining processes. **Abrasive Jet Machining (AJM)**: Abrasive Jet Machining Setup – Gas propulsion System, Abrasive feeder, Machining Chamber, AJM Nozzle; Parametric Analysis – Stand-off-distance, Abrasive flow rate, Nozzle pressure, Mixing ratio; Process Capabilities. **Ultrasonic machining (USM)**: Ultrasonic Machining System, Mechanics of cutting, Model proposed by Shaw – Grain Throwing Model, Grain Hammering Model; Parametric Analysis, Process Capabilities.	**08 Hrs**
Unit – II	
Water Jet Cutting (WJC): WJC Machine, Process Characteristics, Process Performance. Applications, Advantage and Limitations. **Abrasive Water Jet Machining (AWJM**): Working Principle, AWJM Machine – Pumping System, Abrasive Feed System, Abrasive Water Jet Nozzle, Catcher; Process Analysis – Water Jet Pressure during Slotting, Water Flow Rate, Abrasive Flow Rate, Abrasive Particle Size, Abrasive Material, Cutting Parameters – Traverse Speed, Number of Passes, Stand-Off-Distance, Process Capabilities. **Abrasive Flow Machining (AFM)**: Working Principle of Abrasive flow Machining System Process Variables, **Magnetic Abrasive Finishing (MAF)** – Working Principle of MAF, Material Removal and Surface Finish – Type and Size of Grains.	**12 Hrs**
Unit – III	
LASER Beam Machining (LBM): Production of LASERS, Working Principle of LASER Beam Machining, Types of Lasers – Solid State Lasers, Gas Lasers; Process Characteristics. Applications, Advantage and Limitations. **Plasma Arc Machining (PAM):** Working Principle, Plasma Arc Cutting System, Elements of Plasma Arc Cutting System, Process Performance. **Electron Beam Machining (EBM):** Working Principle, Electron Beam Machining System – Electron Beam Gun, Power Supply, Vacuum System and Machining Chamber; Process Parameters, Characteristics of the Process. Applications, Advantage and Limitations.	**10 Hrs**
Unit – IV	
Electrochemical Machining (ECM): Electrolysis, ECM Principle, ECM Machine Tool-Power Source, Electrolyte supply and Cleaning System, Tool and Tool Feed System, Workpiece and Work Holding Device; Theory of ECM – Faraday's Laws of Electrolysis, Electrochemical Equivalent of Alloys, Material Removal Rate in ECM. **Chemical Processes:** Introduction, Maskants – Cut and Peel, Screen Printing, Photoresist Maskant; Electropolishing – Introduction, Process Description, Process parameters, Process limitations, Applications, Advantage and Limitations.	**08 Hrs**
Unit –V	
Non Destructive Testing: Scope and advantages of NDT, comparison of NDT with DT, classifications of NDT, introduction, principle, equipment, procedures and characteristics of Visual Inspection, Eddy Current Testing, Liquid Penetrant Testing, Magnetic Particle Testing and Radiographic Testing.	**10 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the principle, mechanism of metal removal of various unconventional machining processes.

CO2	Analyses the process parameters and their effect on the component machined on various unconventional machining processes and tested using NDT techniques.
CO3	Apply the concept for different NTM and NDT concepts industry.
CO4	Evaluate appropriate NTM and non-destructive techniques.

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

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 is 20+50+30=100 Marks.

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

SECOND SEMESTER

Semester: II						
Mechatronics in Manufacturing Systems (Theory & Practice)						
Course Code	**:**	**18MCM21**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
INTRODUCTION: Definition, Systems, Measurement systems, Control systems-open loop and closed loop control system, Basic elements of a closed loop system, Examples for mechatronic system- water level controller, engine management system, digital camera, washing machine etc. Benefits of mechatronic system, Evolution of mechatronic system. **TRANSDUCERS AND SENSORS:** Sensors and transducers, Performance terminology, Sensors: Displacement, Position, Proximity sensor, Velocity, Force, Fluid pressure, Liquid flow, Liquid level, Temperature, Light, Selection of sensors, Input data by switches.	**09 Hrs**
Unit – II	
Signal Conditioning: Operational amphlifier, Protection, Filtering, Wheatstone bridge, Digital signals, Multiplexer, Data acquisition, Digital signal processing, Pulse modulation. **Mechanical and electrical actuation:** types of motion, kinematic chains, cams, gear trains, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection, mechanical switches, solid state switches, solenoids, DC motor, AC motor, stepper motors, servo motos, induction motors.	**10 Hrs**
Unit – III	
Basic and Dynamic System Models: mathematic models, mechanical system building block, electrical system building block, fluid system building block, thermal system building blocks. System models: engineering system, rotational-translational systems, electromechanical systems, Hydraulic –mechanical systems. Dynamic responses of systems: modeling dynamic systems, first-order system, second-order systems, performance measure for second order systems, system identification.	**10 Hrs**
Unit – IV	
System Transfer functions: Transfer functions, first order systems, second order systems, system in series, system with feedback loops, effect of pole location on transient response. **Frequency response:** Sinusoidal input, phasors, frequency response, bode plots, performance specifications, stability	**10 Hrs**
Unit –V	
Closed Loop Controllers: Continious and discrete processes, control modes, two step mode, proportional mode, derivative control, integral control, PID controller, digital controller, control system performance, controller tuning, velocity control, adaptive control. **Microprocessor and Micrcontroller**: Basic structure of a microprocessor system, architecture, technique used to find faults in microprocessor based system, basic structure of micro-controller, architecture, program development using flow charts.	**09 Hrs**
Unit- VI (Lab Component)	
Hydraulic and Pneumatic lab Experiments: Application Of 4/3 Direction Control Valve (Tandem And Closed Centre), hydraulic system using Rotary Actuator, Design a Hydraulic & Electric Circuit for a hydraulic system Accumulator, Analysis of a Pressure Switch Characteristics in a hydraulic system. Speed Control of a Single Acting Cylinder using pneumatics, Logical Control of pneumatic circuit with AND , OR functions, **Circuit Simulation** - Analysis of Simple Hydraulic Circuits, Meter-In Circuit Analysis, Meter-out circuit, Bleed Off Circuit, Analysis of circuit - valves in series, Analysis of circuit - valves in parallel.	**24P Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Define various types of transducers used in industrial automation and machine control systems.
CO2	Explain the architecture of a microprocessor system
CO3	Describe the working principle of mechanical, electrical, pneumatic and hydraulic actuators
CO4	Design ladder logic based PLC circuit to control various industrial activities

Reference Books:	
1	W.Bolton, Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education-2005, ISBN: 0273742868
2	Mechatronics by HMT Ltd. – Tata Mc GrawHill -2000.ISBN: 007463643X
3	Nitaigour Premchand Mahalik, Mechatronics-Principles, Concepts and Applications, Tata Mc Graw Hill –2003, ISBN:0070483744
4	Anthony Esposito, Fluid Power, Pearson Education-Sixth Edition-2011, ISBN:0135136903

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

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 is 20+50+30=100 Marks.

Scheme of Continuous Internal Evaluation (CIE) for Practicals: (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.

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

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: II						
Tooling for Manufacturing in Automation (Theory)						
Course Code	**:**	**18MCM22**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Cutting Tool Materials: Cutting Technology – an Introduction, The Evolution of Cutting Tool Materials, Tool Coatings: Chemical Vapour Deposition (CVD), Physical Vapour Deposition (PVD), Diamond-Like CVD Coatings, Cubic Boron Nitride (CBN) and Poly-crystalline Diamond (PCD), Natural Diamond. Turning and Chip-breaking Technology: Cutting Tool Technology, Chip-Development, Tool Nose Radius, and Multi-Functional Tooling	**08 Hrs**
Unit – II	
Drilling and Associated Technologies: Drilling Technology, Boring Tool Technology, Reaming Technology. Milling Cutters and Associated Technologies: Milling, Pocketing, Closed-Angle Faces, Thin-Walled and Thin-Based Milling Strategies, Rotary and Frustum-Based Milling Cutters – Design and Operation, Customised Milling Cutter Tooling, Mill/Turn Operations.	**07 Hrs**
Unit – III	
Threading Technologies: Threads, Hand and Machine Taps, Fluteless Taps, Threading Dies, Thread Turning, Thread Milling, Thread Rolling. Modular Tooling and Tool Management: Modular Quick-Change Tooling, Tooling Requirements for Turning Centers, Machining and Turning Centre Tooling, Balanced Modular Tooling for HS.	**07 Hrs**
Unit – IV	
Machinability and Surface Integrity: Machinability, Chatter in Machining Operations, Milled Roundness, Machined Surface Texture, Machining Temperatures, Tool Wear and Life	**07 Hrs**
Unit –V	
Cutting Fluids: Primary Functions, High-Pressure Jet-Assisted Coolant Delivery, Types, Classification, Selecting the Correct Cutting Fluid, Care, Handling, Control and Usage of Cutting Fluids, Multi-Functional Fluids, Disposal of Cutting Fluids, Health and Safety Factors.	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Understand the fundamental concepts Tooling in Manufacturing
CO2	Analyze the concepts of Tooling
CO3	Explain the principles of Tooling
CO4	Evaluate the machining and coolant capabilities

Reference Books:	
1	Graham T. Smith, Cutting Tool Technology- Industrial Handbook‖ - Springer.2 nd Ed, ISBN 978-1- 84800-204-3.
2	Cyrol Donaldson, Tool Design‖ -, Tata McGraw Hill, , India, 4th Ed ISBN 0070992746.
3	Edward G Hoffman, Fundamentals of Tool Design‖ SME, USA. ISBN 0872634906
4	David A.Stephenson, John S. Agapiou, Metal cutting theory and practice‖, CRC Taylor

	and Francis publishers, 2nd Ed. ISBN 0824795792.

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 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 (Common to all programs)						
Course Code	**:**	**18IM23**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

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

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

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

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 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 MCM 24**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P**	**0:0:10**	**SEE Marks**	**:**	**100**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 Hours**

GUIDELINES

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

Course Outcomes:

After going through this course the students will be able to

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

Scheme of Continuous Internal Examination (CIE)

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

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

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

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

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

Scheme for Semester End Evaluation (SEE):

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

1. Brief write-up about the project 5%
2. Presentation / Demonstration of the project 20%

3.	Methodology and Experimental Results & Discussion	25%
4.	Report	20%
5.	Viva Voce	30%

Semester: II						
AUTOMATION AND PRODUCTION SYSTEMS (Group C: Core Elective)						
Course Code	**:**	**18MCM2C1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Production System Facilities, Manufacturing Support Systems, Automation in Production Systems, Manual Labor in Production Systems, Automation Principles and Strategies, Ten Strategies for Automation and Production Systems, Basic Elements of Automated System, Advanced Automation Functions, Levels of Automation.	**10 Hrs**
Unit – II	
Basic Elements of an Automated System: Process Industries Versus Discrete Manufacturing Industries, Continuous Versus Discrete Control, Computer process control Forms of Computer Process Control. **Sensors, Actuators, and Other Control System Components:** Sensors, Actuators, Analog-to-Digital Conversion, Digital-to-Analog Conversion, Input / Output Devices for Discrete Data.	**10 Hrs**
Unit – III	
Discrete Control Using Programmable Logic Controllers and Personal Computers: Discrete Process Control, Ladder Logic Diagrams, Programmable Logic Controller, Personal Computers Using Soft Logic. **Material Handling and Transportation System**: Overview Material Handling Equipment, Considerations in Material Handling System Design, Principles of Material Handling, Industrial Trucks, Automated Guided Vehicle Systems, Monorails and Other Rail Guided Vehicles, IDA Conveyors Systems, Crane and Hoists, Analysis of Material Transport Systems.	**10 Hrs**
Unit – IV	
Storage Systems: Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated storage systems, Engineering Analysis of Storage System.	**09 Hrs**
Unit –V	
FMS and Automated System Assembly: What is FMS, FMS Components, FMS Applications and Benefits, FMS Planning and Implementation Issues, Quantitative Analysis of Flexible Manufacturing Systems, Fundamentals of Automated Assembly Systems, Design for Automated Assembly, Quantitative Analysis of Assembly Systems	**09 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Classify the types of Automation and Production System
CO2	Analyze the concepts of Automation
CO3	Apply the concepts of mathematical equation in material handling and AS/RS and Automation System
CO4	Evaluate the techniques involved in FMS

Reference Books:	
1	David J Parrish, Flexible manufacturing, Butterworth-Heinemann Publisher, 1990 ISBN: 9780750610117
2	Mikell P Groover Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall India (P) Ltd, 2008 ISBN: 9780132393218
3	William W. Luggen Flexible Manufacturing Cells & Systems, Prentice hall, 2006, ISBN: 9780133217384

4	Viswanadham N, Narahari Y, Performance Modeling of Automated Manufacturing Systems, Prentice Hall of India (P) Ltd, 1992. ISBN: 9780136588245

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 is 20+50+30=100 Marks.

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

Semester: II						
DESIGN FOR MANUFACTURE & ASSEMBLY (Group C: Core Elective)						
Course Code	**:**	**18MPD2C2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction to Design for Manufacture & Assembly: Steps in DFMA, Advantages of DFMA, Design guidelines for Manual Assembly and High Speed Automatic and Robotic Assembly **Geometrical Dimensioning & Tolerance –** Dimensions & Tolerance, Limits, Fits and Tolerances, Hole and Shaft Basis, Three datum – functional, machining and manufacturing, geometrical and form tolerance, conventional and advanced tools and techniques for measurements, numerical	**10 Hrs**
Unit – II	
Metal Casting Processes – Gravity Die Casting : compute the dimensions for Pattern, Mould, based on materials to be cast – ferrous and non-ferrous alloys, influence of parting line, cast holes, special sand cores, shrinkage compensation, numericals, **Pressure Die Casting:** Die casting alloys, machine selection, operation, sub-systems, post-processing equipments, mould design, number of cavities, manufacturing and assembly of moulds, design principles.	**10 Hrs**
Unit – III	
Design for Injection Molding – Injection moulding systems – injection subsystem, ejection system, clamping and feeding system, machine sizing, materials for injection moulding and its properties, injection mould design – cavity and core, manufacturing processes for moulds, operation and cycle time.	**10 Hrs**
Unit – IV	
Design for Powder Metallurgy Processes: Introduction to PM process, blending and mixing, compaction, sintering processes. Tooling materials, heat treatment, surface treatments and preparation of green compacts, Press tools for PM process – load, tooling layout, capacity; sintering furnace and influence of process and materials parameters on shrinkage.	**10 Hrs**
Unit –V	
Design for Sheet Metal Processing : Design of moulds for shearing, piercing, bending, deep drawing, progressive die operation, selection of press – hydraulic and electric, sub-systems, turret operation, cycle time calculation, laser cutting of sheet metals. **Cost Estimation** for sand casting, pressure die casting, injection moulding, PM process and sheet metal processes.	**08 Hrs**

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	Geoffrey Boothroyd, Peter Dewhurst, Winston Knight Marcel Dekker, Inc., Product Design for Manufacture and Assembly, –Newyork - Second Revision, ISBN 0-8247-0584-X
2	Harry Peck, Designing for Manufacturing, Pitman Publications,1983, ISBN: 1-85233-810-5
3	Merhyle F Spotts, Englewood Cliffs, Dimensioning and Tolerance for Quantity Production 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

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 is 20+50+30=100 Marks.

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

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

Semester: II						
COMPUTER APPLICATION IN DESIGN (Group C: Core Elective)						
Course Code	**:**	**18MCM2C3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Points, lines and planar curves: Vector algebra **Shapes inside a computer:** Review of geometry and trigonometry, Points in a plane: Position vectors, Angles between lines - introducing the third dimension: Scalar products, Finding normal to planes: Vector products, Following a line: Parameters	**08 Hrs**
Unit – II	
Lines in space: Vector equations: Lines in two-dimensional space, in three-dimensional space, Different parametric forms; Lines and common curves: Parametric and Cartesian forms: Linearity and non-linearity, Functions, The parabola, The circle, The ellipse, The circular helix **Transformations:** Matrix algebra, Tools for transformations: Matrices, Transformations, Matrices, Adding and subtracting matrices, Multiplying matrices; Moving in a plane: Scaling, reflection and rotation: Matrices as geometric operators, Scaling position vectors, Reflecting position vectors in the axes, Rotating position vectors about the origin, Transforming polygons	**12 Hrs**
Unit – III	
Combining transformations: Translations, Order in combining transformations, Specific combinations of transformations, Translations, (3x3) Matrices for transformations in a plane Sizing things up: Homogeneous vectors: Simple homogeneous vectors, General homogeneous vectors, Matrix operations using homage vectors **Useful manoeuvres**: Non-standard rotations and reflections the viewing transformation: Standard and standard, Rotation about an arbitrary point, Reflection in an arbitrary line, The viewing transformation **The third dimension:** Moving along rays, points at infinity and three-dimensional transformations: Geometrical insights using homogeneous vectors, Completing consideration of (3*3) matrices, Points at infinity, Three dimensional transformations, Some specific (4x4) matrices, Local scaling, Reflections in the coordinate planes, Rotations about the coordinate axes, Translation, Overall scaling, In conclusion	**12 Hrs**
Unit – IV	
Points of view: Projection and single point perspective: Projection from three dimensions onto a plane, Orthographic projection, The need for perspective, Single point perspective, Perspective projection, Tunnel perspective, To improve realism **A greater sense of perspective:** Two point and three point perspective: Improving perspective, Translation then single point perspective, Rotation then single point perspective, giving two points perspective, Rotation, translation then single point perspective improved two point perspective, Two rotations, translation then single point perspective, giving three point perspective, The three types of perspective-projection, Vanishing points and trace points **Space curves and surfaces:** Differentiation, Slopes of lines and planar curves: Gradient functions: Lines and curves, Slope of a straight line from its Cartesian equation, Slope of a curve from its Cartesian equation, Practical rules for differentiation, Slope of a straight line from its vector equations **Slopes of space curves:** Tangents and normal, Space curves, The tangent vector to a space curve, Tangents and normals for curves in a plane, Tangents and normals in three	**08 Hrs**

dimensions	
Unit –V	
Curve fitting: Interpolation and shape function: Lines and curves from real objects, Linear interpolation, Quadratic interpolation, Uniqueness **Planes and surfaces:** Bi parametric forms: sweeps and revolutions, Surface formulae and two parameters, Vector equations of planes, The vector equation of a plane, given two vectors in the plans, The vector equation of a plane, given two unit vectors in the plane, The vector equation of a plane, given three points in a plane, Parameter lines and parameter planes, Plotting a plane, The implicit form of equation of a plane, Generating a swept surface, Generating a surface of revolution **Wire frame surfaces surface Tangents and normal:** Partial differentiation: General surfaces, Forming a wire frame, Carved surfaces from the, Partial differentiation, Surface tangents and surface normal. **Piecewise surfaces Quadrilateral patches:** Dividing up surfaces, A quadrilateral patch on a sphere, Bilinear patches, Linear Coons patches.	**08 Hrs**

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	P A Eagerton and W S Hall, Computer Graphics, Mathematical first steps, Prentice Hall, Europe,1998, ISBN: 0-13-599572-8
2	Chennakesava R Alavala, CAD/CAM Concepts and Applications, 1st Ed PHI, New Delhi, 2009 ISBN 978-81-203-3340-6
3	P.N. Rao, CAD/CAM Principles and Applications, 3rd Ed., McGraw Hill, Education Pvt Ltd., New Delhi ISBN 0-07-058373-0
4	Ibrahim Zeid, Mastering CAD/CAM , 2nd Ed., TMH Publishing Company Limited., New Delhi, ISBN 0-07-0634334-3
5	M.P. Groover and 3 E W Zimmers, CAD/CAM Computer aided Design and Manufacturing, 9th Ed, 1993, ISBN 81-203-0402-0

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 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 METROLOGY (Group D: Core Elective)						
Course Code	**:**	**18MCM2D1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
INTRODUCTION TO METROLOGY: Basic Concepts - Legal Metrology - Precision - Accuracy - Types of errors –least square fit. Linear and Angular Measurements - Standards of Measurements - Calibration - Interchangeability and selective assembly- Gauges for inspection-types- Gauge design-Taylor's principle- Introduction to Comparators - Types of Comparators - Mechanical, Mechanical - Optical, Electrical and Electronic, pneumatic-flow type differential pressure type.	**08 Hrs**
Unit – II	
MEASUREMENTS OF SCREW THREAD - GEAR ELEMENTS – SURFACE FINISH: Internal and External screw threads: Measurements of various elements of thread - Best size wire - Two and three wire method. Gear: Measurements of various elements - Constant chord method - Base tangent method. Surface Finish: Surface topography definitions - Measurement of Surface Texture - Methods - Evaluation of Surface finish.	**10 Hrs**
Unit – III	
OPTICAL METROLOGY and NON CONTACT MEASUREMENT TECHNIQUES: Principle of light wave interference - Light sources –Measurement with optical flats-Types of Interferometers - Michelson, Twyman Green Specialization of Michelson, NPL flatness Interferometers, The Pitter NPL gauge - laser interferometer- laser micrometer- surface roughness measurement using laser. Laser Telemetry systems, Laser and Lead based distance measuring instruments.Laser based small diameter and large displacment measurments.	**10 Hrs**
Unit – IV	
COORDINATE METROLOGY AND FORM MEASUREMENT: Coordinate Measuring Machine-components of CMM-types-measuring head -types of probe- alignment error-causes of error -measuring accuracy-calibration of CMM performance of CMM-applications-measurement integration, Measurement of straightness - Flatness - squareness - parallelism - circularity – roundness and run out.	**10 Hrs**
Unit –V	
ADVANCES IN METROLOGY- Mision Vision:Image Analysis and Computer Vision, Computer Vision Systems, Image Analysis Techniques, Digital Image Processing, Challenges in Image Processing-Image, Vision System for Measurement, Comparision ofLaser scanning and Vision system. MACHINE TOOL TESTING USING LASER INTERFEROMETER- Alignment, Tooling Laser, Photodetectors, Auto reflectors, Autocollimation, Combines measurement of Tilt and Displacement. Rotation about z-axis, High precision alignment.	**10 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the fundamental concepts of metrology
CO2	Apply the knowledge to use the various measuring instrument precisisly and accuratly.
CO3	Apply the knowledge of laser measurements and machine vision in various manufacturing techniques
CO4	Suggest advanced measurement techiques over conventional techniques in the area of advanced manufacturing fields

Reference Books:	
1	Jain.R.K, Engineering Metrology, Khanna Publishers, New Delhi, 2012.ISBN 13:9788174091536

2	Kevin G Harding, Handbook of Optical Dimensional Metrology, CRC Press, A Taylor & Francis group, 2013. ISBN: 9781439854815.
3	Robert.JHocken, Paulo H. Pereira,Coordinate, Measuring Machines and Systems, CRC Press,Taylor& Francis Group, 2011. ISBN:9781574446524.
4	Connie Dotson, "Dimensional Metrology" Cengage Learning (India Edition), ISBN-13:978-81-315-0823-7

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 is 20+50+30=100 Marks.

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

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

Semester: II						
ROBOTICS & AUTOMATION (Group D: Core Elective)						
Course Code	**:**	**18MCM2D2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Automation and Robotics - Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies. Concepts and Model about Basic Control System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Control Approaches of Robots	**07 Hrs**
Unit – II	
Kinematics of Robot Manipulator: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation & Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation	**10 Hrs**
Unit – III	
Robotic Workspace & Motion Trajectory: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. Robotic Motion Trajectory Design: – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories: 4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.	**12 Hrs**
Unit – IV	
Dynamics of Robotic Manipulators: Introduction, Bond Graph Modeling of Robotic Manipulators, Examples of Bond Graph Dynamic Modeling of Robotic Manipulator. Brief Discussion on Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Preliminary Definitions, Generalized Robotic Coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic Mass Distribution & Inertia Tensors, Newton's Equation, Euler Equations, The Lagrangian& Lagrange's Equations. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass, Dynamic Equations of Motion for A General Six Axis Manipulator.	**12 Hrs**
Unit –V	
Autonomous Robot: Locomotion Introduction, Key issues for locomotion Legged Mobile Robots Leg configurations and stability Examples of legged robot locomotion Wheeled Mobile Robots Wheeled locomotion: the design space Wheeled locomotion: case studies Mobile Robot Kinematics Introduction Kinematic Models and Constraints Representing robot position Forward kinematic models Wheel kinematic constraints Robot kinematic constraints, Mobile Robot Maneuverability Degree of mobility Degree of steerability Robot maneuverability.	**07 Hrs**

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

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 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						
SUPPLY CHAIN MANAGEMENT (Group D: Core Elective)						
Course Code	**:**	**18MCM2D3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**48L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction to Supply Chain Management: Definition of Supply Chain Management (SCM), Development Chain, Global Optimization, Managing Uncertainty and Risk, Evolution of SCM Complexity, Key Issues. **Inventory Management:** Introduction, Single stage Inventory control – Economic Lot Size, Effect of demand uncertainty, Single period models, Inventory, Multiple order Opportunities, Continuous review policy, Variable lead times, Periodic Review policy, Service Level optimization. **Risk Pooling:** Centralized vs Decentralized Supply Chains, Managing Inventory in Supply chain, Forecasting, Judgement methods, Market Research methods, Time series methods, Causal methods, Selection of appropriate technique.	**10 Hrs**
Unit – II	
Network Planning: Introduction, Network Design – Data collection, Aggregation, Transportation rates, Mileage estimation, Warehouse costs, Warehouse capacities, Potential warehouse locations, Service level requirements, Future demand, Model and data validation, Solution techniques, Key features of Network Configuration, Supply Chain Planning, Inventory positioning and Logistics coordination, Strategic safety stock. **Supply Contracts:** Introduction, Strategic components, Supply contracts, Limitations, Contracts for Made to stock/Make to order Supply chains, Contracts with Asymetric Information, Contracts for Nonstrategic components.	**10 Hrs**
Unit – III	
The Value of Information: Introduction, the Bull whip effect, Information sharing and Incentives, Effective forecasts, Information for coordination of systems, Locating desired products, Lead time reduction, Information and Supply chain trade-offs, Decreasing marginal value of information. **Supply Chain Integration:** Introduction Push, Pull and Push-Pull Systems, Identifying the appropriate Supply chain strategy, Implementing a Push-Pull Strategy, Impact of Lead Time, Demand driven Strategies, Impact of Internet on Supply Chain Strategies.	**10 Hrs**
Unit – IV	
Strategic Alliances: Introduction, Framework for strategic alliance, Third Party Logistics, Retail- Supplier relationships, Distributor Integration. **Procurement and Outsourcing Strategies:** Introduction, Outsourcing Benefits and Risks, Framework for Buy/Make decisions, Procurement strategies, E-procurement. **Smart Pricing:** Introduction, Price and Demand, Markdowns, Price differentiation, Revenue Management, Smart Pricing, Impact of the Internet.	**09 Hrs**
Unit –V	
Global Logistics and Risk Management: Introduction, Risk Management, Issues in International Supply Chain Management, Regional differences. **Distribution Strategies:** Introduction Direct Shipment Distribution Strategies, Intermediate Inventory storage point strategies.	**09 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain supply chain concepts, systemic and strategic role of SCM in global competitive environment.
CO2	Apply various supply chain models for different decision scenarios.

CO3	Evaluate alternative supply chain strategies using optimization and other models.
CO4	Analyze the given situation and develop appropriate supply chain strategy.

Reference Books:	
1	David Simchi Levi, Philip Kaminsky, Edith Simchi Levi & Ravi Shankar; "Designing & Managing the Supply Chain – Concepts Strategies and Case Studies"; Mc Graw Hill, 3rd Edition, 2008, ISBN: 978- 0-07-066698-6.
2	Sunil Chopra, Peter Meindl & D V Kalra: "Supply Chain Management - Strategy, Planning & Operation"; Pearson Education Asia; 5th Edition, 2013, ISBN: 978-0-13-274395-2.
3	Sarika Kulkarni & Ashok Sharma: "Supply Chain Management – Creating Linkages for Faster Business Turnaround", TATA Mc Graw hill, 1st Edition, 2004, ISBN: 0-07-058135—5
4	Jeremy F Shapiro, Duxbury; "Modelling the Supply Chain", Thomson Learning, 2002 Edition, ISBN 0-534-37363.

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 is 20+50+30=100 Marks.

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

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

Semester: II						
BUSINESS ANALYTICS (Group G: Global Elective)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.	**08 Hrs**
Unit – II	
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	**07 Hrs**
Unit – III	
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.	**08 Hrs**
Unit – IV	
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.	**07 Hrs**
Unit –V	
Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	**06 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

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

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 is 20+50+30=100 Marks.

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

Semester: II						
INDUSTRIAL & OCCUPATIONAL HEALTH AND SAFETY (Group G: Global Elective)						
Course Code	**:**	**18CV2G02**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	**07 Hrs**
Unit – II	
Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.	**07 Hrs**
Unit – III	
Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.	**08 Hrs**
Unit – IV	
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	**07 Hrs**
Unit –V	
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the Industrial and Occupational health and safety and its importance.

CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

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

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 is 20+50+30=100 Marks.

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

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

Semester: II						
MODELING USING LINEAR PROGRAMMING (Group G: Global Elective)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

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

Course Outcomes: After going through this course the student will be able to:	
CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books:	
1	Taha H A, Operation Research An Introduction, PHI, 8th Edition, 2009, ISBN: 0130488089.
2	Philips, Ravindran and Solberg - Principles of Operations Research – Theory and Practice, John Wiley & Sons (Asia) Pvt Ltd, 2nd Edition, 2000, ISBN 13: 978-81-265-1256-0
3	Hiller, Liberman, Nag, Basu, Introduction to Operation Research, Tata McGraw Hill 9th Edition, 2012, ISBN 13: 978-0-07-133346-7
4	J K Sharma, Operations Research Theory and Application, Pearson Education Pvt Ltd, 4th Edition, 2009, 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 is 20+50+30=100 Marks.

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

Semester: II						
PROJECT MANAGEMENT (Group G: Global Elective)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
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.	**07 Hrs**
Unit – II	
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	**07 Hrs**
Unit – III	
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	**08 Hrs**
Unit – IV	
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	**07 Hrs**
Unit –V	
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.	**07 Hrs**

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	Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 8th Edition, 2010, ISBN 0-07-007793-2.
2	Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
4	Rory Burke, "Project Management – Planning and Controlling Techniques", John Wiley & Sons, 4th Edition, 2004, 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 is 20+50+30=100 Marks.

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

Semester: II						
ENERGY MANAGEMENT (Group G: Global Elective)						
Course Code	**:**	**18CH2G05**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Energy conservation: Principles of energy conservation and energy audit, types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat recuperators- classification, liquid/gas and gas/liquid heat exchangers	**07 Hrs**
Unit – II	
Wet Biomass gasifiers: Introduction, Classification of feedstock for biogas generation. Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages, Biogas from aquatic weed.	**07 Hrs**
Unit – III	
Dry Biomass Gasifiers : Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers. Pyrolysis.	**08 Hrs**
Unit – IV	
Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. **Wind Energy:** Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, and applications	**07 Hrs**
Unit –V	
Alternative liquid fuels: Introduction. Ethanol production: Raw materials, Pre-treatment, Conversion processes, Fermentation systems. Methanol production: Raw materials, Gasification of wood, Gas purification and shift conversion, Synthesis, Gasification equipment.	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Understand the use alternate fuels for energy conversion
CO2	Develop a scheme for energy audit
CO3	Evaluate the factors affecting biomass energy conversion
CO4	Design a biogas plant for wet and dry feed

Reference Books:	
1	Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
4	C. S. Solanki, Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009, ISBN:9788120343863

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 is 20+50+30=100 Marks.

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

Semester: II						
INDUSTRY 4.0 (Group G: Global Elective)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	**07 Hrs**
Unit – II	
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	**07 Hrs**
Unit – III	
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.	**08 Hrs**
Unit – IV	
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	**07 Hrs**
Unit –V	
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.	**07 Hrs**

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	Alasdair Gilchrist, Industry 4.0 The Industrial Internet Of Things, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Alp Ustundag, Emre Cevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018 ISBN 978-3-319-57869-9.

3	Ovidiu Vermesan and Peer Friess, Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4	Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

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 is 20+50+30=100 Marks.

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

Semester: II						
ADVANCED MATERIALS (Group G: Global Elective)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	**07 Hrs**
Unit – II	
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.	**07 Hrs**
Unit – III	
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	**08 Hrs**
Unit – IV	
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.	**07 Hrs**
Unit –V	
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	**07 Hrs**

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	Donald R. Askeland, and Pradeep P. Fulay, The Science & Engineering of Materials, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Gregory L. Timp, Nanotechnologym 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Dr. VD Kodgire and Dr. S V Kodgire, Material Science and Metallurgym 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	N Bhatnagar, T S Srivatsan, Processing and Fabrication of Advanced Materials, 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 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 is 20+50+30=100 Marks.

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

Semester: II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Group G: Global Elective)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

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

Course Outcomes: After going through this course the student will be able to:	
CO1	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
CO2	Identify the basic constituents of a composite materials and the list the choice of materials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nanomaterials.

Reference Books:	
1	Krishan K Chawla- Composite Materials Science and Engineering" Springer-verlag Gmbh, 3rd Edition, ISBN: 9780387743646, 0387743642
2	K Balani, Donald R Askeland, - "The Science Engineering of Materials" 6th Edition- Cengage, ISBN: 9788131516416
3	Joel R Fried- "Polymer Science and Technology", 2nd Edition, Prentice Hall, ISBN: 9780137039555
4	Rajendra Kumar Goyal-"Nanomaterials and nanocomposites", 2nd Edition, CRC Press-Taylor & Francis, ISBN: 9781498761666, 1498761666

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 is 20+50+30=100 Marks.

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

Semester: II						
PHYSICS OF MATERIALS (Group G: Global Elective)						
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
CRYSTAL STRUCTURE: Symmetry elements-seven crystals systems-Reciprocal lattice-Packing fraction, Lattice Vibration-Brillouin zones, Analysis of Crystal structure using XRD, Thermal properties.	**07 Hrs**
Unit – II	
DIELECTRIC MATERIALS: Basic concepts-Lange in's Theory of Polarisation-Clausius-Mossotti Relation-Ferro electricity-Piezoelectricity-Properties of Dielectric in alternating fields-The complex Dielectric Constant and Dielectric Loss, Polarizability as a function of frequency-Complex dielectric constant of non-polar solids-Dipolar relaxation, Applications.	**07 Hrs**
Unit – III	
MAGNETIC MATERIALS: Dia and Paramagnetic materials-Quantum theory of paramagnetic materials-Paramagnetic susceptibility of conduction electrons-Ferro-anti ferromagnetic materials-Superconductors and Applications.	**08 Hrs**
Unit – IV	
SEMICONDUCTING MATERIALS : Semiconductor-Direct and Indirect bonding characteristics-Importance of Quantum confinement-quantum wires and dots-Ferro electric semiconductors-applications-Polymer semiconductors-Photo conductive polymers, Applications.	**07 Hrs**
Unit –V	
NOVEL MATERIALS: Smart materials-shape memory alloys-shape memory effects-Martensitia Transformation functional properties-processing-texture and its nature.	**07 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Analyse crystals using XRD technique.
CO2	Explain Dielectric and magnetic materials.
CO3	Integrate knowledge of various types of advanced engineering Materials.
CO4	Use materials for novel applications.

Reference Books:	
1	Solid State Physics, S O Pillai, 2015, New Age International Publishers, ISBN 10-8122436978.
2	Introduction to Solid State Physics, C.Kittel, Seventh Edition, 2003, John Wiley & Sons, ISBN 9971-51-180.
3	Material Science, Rajendran V and Marikani, , Tata McGraw Hill, 2013, ISBN 10-007132871.
4	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, Sixth Edition, 2012 Cengage Learning, ISBN-13:978-0-495-66802-2.

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 is 20+50+30=100 Marks.

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

Semester: II						
ADVANCED STATISTICAL METHODS (Group G: Global Elective)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L**		**SEE Duration**	**:**	**3 hrs**

Unit – I	
Sampling Techniques: Random numbers, Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement). Expectation and standard error of sample mean and proportion.	**07 Hrs**
Unit – II	
Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Properties of maximum likelihood estimator (no proofs), Confidence intervals-population mean (large sample), population proportion.	**07 Hrs**
Unit – III	
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples, Simple and composite hypothesis, Null and alternative hypothesis, Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Chi squared test for goodness of fit.	**07 Hrs**
Unit – IV	
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.	**07 Hrs**
Unit –V	
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.	**08 Hrs**

Course Outcomes: After going through this course the student will be able to:	
CO1	Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.
CO2	Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions.
CO3	Analyze the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations

Reference Books:	
1	A. M. Goon, M. K. Gupta and B. Dasgupta-Fundamentals of Statistics (Vol. I and Vol. II), World Press Private Limited, 3rd Edition, 1968, ISBN-13: 978-8187567806.
2	D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, John Wiley & Sons, Inc., 3rd Edition, 2003, ISBN 0-471-20454-4.

3	S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistic - A Modern Approach, S Chand Publications, 10th Edition, 2000, ISBN 81-7014-791-3.
4	Regression Analysis: Concepts and Applications – F. A. Graybill and H. K. Iyer, Belmont, Calif.: Duxbury Press, 1994, ISBN-13: 978-0534198695.

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

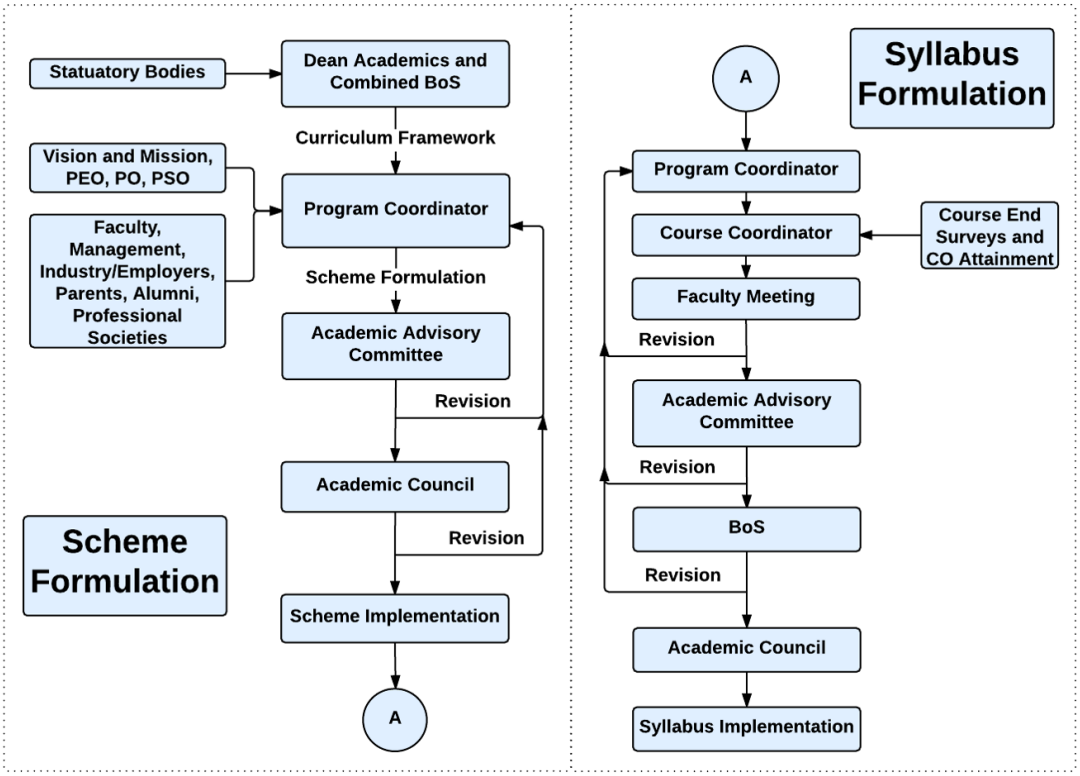
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum 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 is 20+50+30=100 Marks.

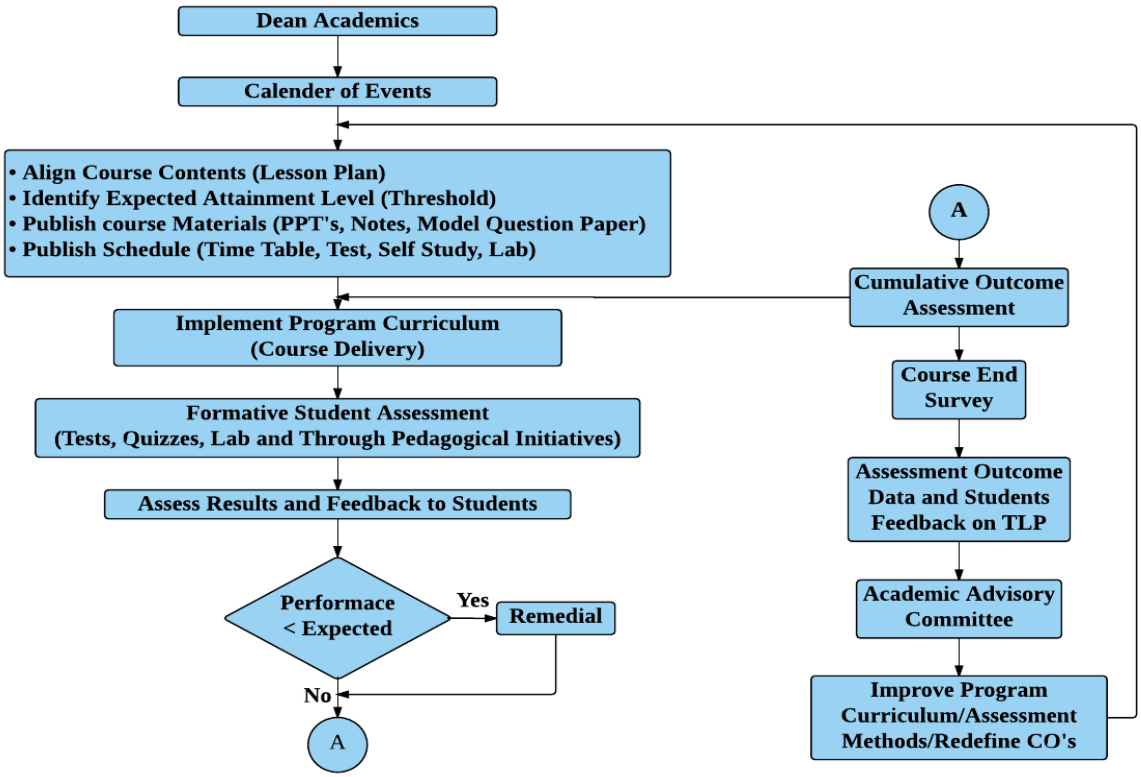
Scheme of Semester End Examination (SEE) for 100 marks:

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.

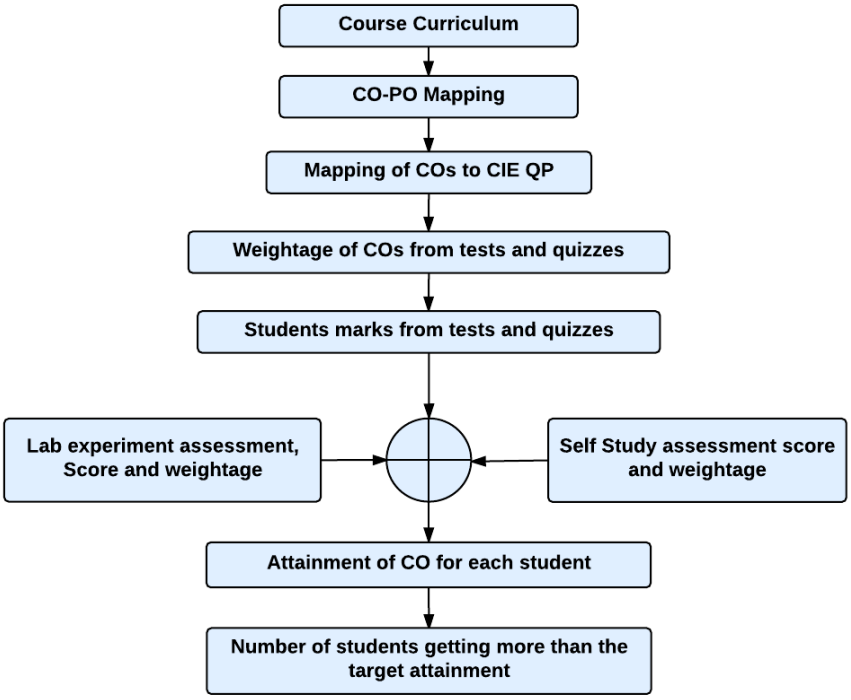
Curriculum Design Process



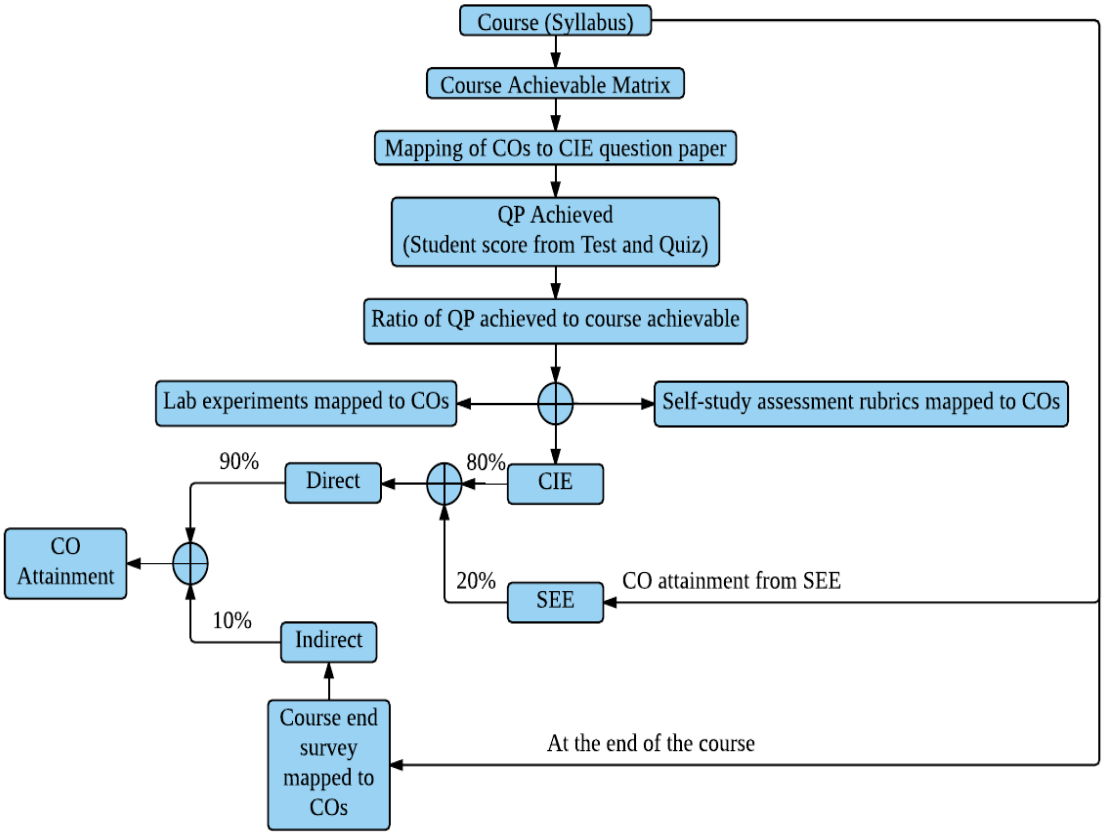
Academic Planning And Implementation



Process for Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process