RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road
Bengaluru – 560059

Scheme and Syllabus of I to IV Semester

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
COMPUTER INTEGRATED MANUFACTURING

DEPARTMENT OF

MECHANICAL ENGINEERING

VISION

Leadership in Quality Technical education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

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

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

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Master of Technology (M.Tech)
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DEPARTMENT OF

MECHANICAL ENGINEERING

DEPARTMENT OF
MECHANICALENGINEERING

VISION

To achieve leadership in the field of Computer Science and Engineering by strengthening fundamentals and facilitating interdisciplinary sustainable research to meet the ever growing needs of the society.

MISSION

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

PROGRAMME 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	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Signal Processing &Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

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FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**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				**18**	**4**	**4**	**26**

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				**21**	**2**	**6**	**29**

SEMESTER : I		
GROUP A: PROFESSIONAL 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: PROFESSIONAL ELECTIVES		
1.	18 MPD1B1	Product Data Management
2.	18MCE1B2	Intelligent Systems
3.	18 MCM 1B3	Non-Traditional Machining & Testing
SEMESTER : II		
GROUP C: PROFESSIONAL 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: PROFESSIONAL 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**
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2.	CV	18CV2G02	Industrial & Occupational Health and Safety	03
3.	IM	18IM2G03	Modelling using Linear Programming	03
4.	IM	18IM2G04	Project Management	03
5.	CH	18CH2G05	Energy Management	03
6.	ME	18ME2G06	Industry 4.0	03
7.	ME	18ME2G07	Advanced Materials	03
8.	CHY	18CHY2G08	Composite Materials Science and Engineering	03
9.	PHY	18PHY2G09	Physics of Materials	03
10.	MAT	18MAT2G10	Advanced Statistical Methods	03

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THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MCM31	Digital Manufacturing	ME	4	1	0	**5**
2	18MCM32	Internship	ME	0	0	5	**5**
3	18MCM3	Major Project : Phase-I	ME	0	0	5	**5**
4	18MCM3EX	Professional Elective-E	ME	4	0	0	**4**
Total number of Credits				**8**	**1**	**10**	**19**
Total Number of Hours/Week				**8**	**2**	**20**	**30**

SEMESTER : III		
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Sl. No.	**Course Code**	**Course Title**
1	18MCM3E1	Additive Manufacturing
2	18MPD3E2	Surface Engineering
3	18MCM3E3	Advanced Manufacturing Practices

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MCM41	Major Project : Phase-II	CS	0	0	20	**20**
2	18MCM42	Technical Seminar	CS	0	0	2	**2**
Total number of Credits				**0**	**0**	**22**	**22**
Total Number of Hours / Week				**0**	**0**	**44**	**44**

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

Unit – I	**9 Hrs**

Statistics:
Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation..

Unit – II	**9 Hrs**

Probability distributions:

Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.

Unit – III	**9 Hrs**

System of linear equations and eigen value problems:

System of linear equations-LU decomposition and Gauss-Jordan method, Eigen value problems–bounds on eigen values, Power method and Inverse Power method, Eigen values and eigen vectors of real symmetric matrices-Jacobi method.

Unit – IV	**10 Hrs**

Numerical solution of differential equations :

Boundary value problems (BVP's)–finite difference method for linear and nonlinear problems, Shooting method and Galerkin method. Finite differences-implicit and explicit scheme, Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations, Finite element method and simple problems.

Unit – V	**10 Hrs**

Engineering optimization:

Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems..

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

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

Reference Books

1	Theory and Problems of probability, Seymour Lipschutz and Marc lars Lipson,Schaum's Outline Series, 2nd edition, ISBN: 0-07-118356-6.

2	Introductory method of numerical analysis, S. S. Sastry, Prentice-Hall India Pvt. Ltd. 4th edition, 2009, ISBN : 81-203-1266-X.
3	Numerical methods for scientific and engineering computation, M K Jain, S. R. K. Iyengar, R. K. Jain, New Age International Publishers, 6th edition; 2012, ISBN-13:978-81-224-2001-2.
4	Engineering Optimization Theory and Practice, Singiresu S. Rao, 3rd edition, New Age International (P)Ltd., ISBN: 81-224-1149-5.

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : I						
COMPUTER CONTROL OF MANUFACTURING SYSTEMS (THEORY &PRACTICE))						
Course Code	**:**	**18MCM12**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 + 3Hrs**

Unit – I	**10 Hrs**
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	
Unit – II	**11 Hrs**
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.	
Unit – III	**11 Hrs**
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.	
Unit – IV	**10 Hrs**
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.	
Unit – V	**10 Hrs**
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	
Unit- VI (Lab Component)	**26 Hrs**
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 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	Computer Controls of Manufacturing Systems, M. Koren, Tata McGraw-Hill Edition 2005 ISBN 0-07-060743-5
2	CAD/CAM Principles and Applications, P.N. Rao, Tata McGraw-Hill 2nd Edition, 2006. ISBN 10: 0070681937 / ISBN 13: 9780070681934.
3	Computer Numerical Control Machines and Computer Aided Manufacture, P Radhakrishnan, 1st Edition, 2012. ISBN: 9788122433975, 8122433979
4	Automation, Production Systems and Computer Integrated Manufacturing, Groover M P, Prentice Hall India (P) Ltd, 3rd Edition. ISBN 10: 0133499618 ISBN 13: 9788120334182

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

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

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

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

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

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: I						
DATA SCIENCE (Theory and Practice)						
Course Code	**:**	**18MPD13**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 + 3Hrs**

Unit – I	**10 Hrs**
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	
Unit – II	**11 Hrs**
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	
Unit – III	**11 Hrs**
Two Dimensional Problems : Three nodedtriangular elements – four nodedrectangular elements – higher order elements – Lagrange approach - iso-parametric, super-parametric, sub-parametric elements	
Unit – IV	**10 Hrs**
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	
Unit – V	**10 Hrs**
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	
UNIT-VI (Lab Component)	**2 Hrs/week**
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 **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	

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

References

1	Fundamentals of FEM, Hutton, Tata McGraw Hill education Pvt. Ltd, 2005, ISBN: 0070601224
2	First Course in Finite element methods, Daryl L Logan, 5th Edition, Thomson Brooks, 2011, ISBN : 10:0495668257
3	Introduction to FE in engineering, T R Chandrupatla, A D Belegondu, 3rd Edition, Prentice Hall, 2004

4	Finite Element method in machining processes, Angelos.P. Markopoulos, Springer series, 2013, ISBN: 978-1-4471-4330-7

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

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

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

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

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

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

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

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

Course Outcomes

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

CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books

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

Phase	**Activity**

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

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

Unit – I	**07 Hrs**

Design for quality : Taguchi's Approach to Quality, On-line and Off-line Quality Control, , Quality Loss Function, System Design, Parameter Design, Design for Environment, Human factor design, Design for casting and forging , Causes of Variation.

Unit – II	**08 Hrs**

Quality Function Deployment –Introduction, QFD team, benefits, voice of customer, organisation of information, house of quality, QFD process

Design of Experiments: Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design

Unit – III	**08 Hrs**

Failure Mode Effect Analysis: Refining geometry and layout, Failure tree analysis, Defects and failure modes Techniques of failure analysis, Filed inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.

Unit – IV	**08 Hrs**

Statistical Consideration in Product Design and Development

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution- Statistical Process control–Scatter diagrams – Multivariable charts

Unit – V	**08 Hrs**

Six Sigma – Overview, Basics and history of the approach for six sigma, Methodology and focus, the application of Six Sigma in production and in service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy

Course Outcomes

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

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

Reference Books

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

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : I						
TRIBOLOGY (Professional Elective-A2)						
Course Code	**:**	**18MMD1A2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **07 Hrs**

Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems

Unit – II **08 Hrs**

Hydrodynamic Lubrications: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems.

Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Somerfield number and its significance, partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.

Unit – III **08 Hrs**

Hydrostatic Bearings: Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems

Antifriction bearings: Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.

Unit – IV **08 Hrs**

EHL Contacts: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.

Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages.

Unit –V **08 Hrs**

Magnetic Bearings: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings

Course Outcomes

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

CO1:	Demonstrate fundamentals of tribology, lubricants and methods of lubrication
CO2:	Analyze bearings for load carrying capacity, frictional force and power loss
CO3:	Illustrate the different modes of lubrication system for various applications.
CO4:	Design the different bearing system such as antifriction bearings, magnetic bearings and porous bearings for various applications

Reference Books

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

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : I						
DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS (Professional Elective-A3)						
Course Code	**:**	**18MCM1A3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **07 Hrs**

Introduction to Hydraulic System: Introduction, Basic hydraulic system, classification of hydraulic motors, hydraulic pumps, Performance of hydraulic motors, Hydraulic actuators, types of hydraulic actuators.

Control Components in Hydraulic Systems: Introduction, Direction control valves, Solenoid actuated valve, Pilot operated valve, Rotary spool DCV, Pressure control valves, Hydraulic fuse, Flow control valve, graphic symbols.

Unit – II **08 Hrs**

Maintenance of Hydraulic Systems: Prime function of hydraulic fluids, desirable properties of hydraulic fluids, general types of fluids, factors affecting the selection of fluids, sealing devices, reservoir systems, filters and strainers, heat exchangers, pressure switch, wear of moving parts, troubleshooting of hydraulic systems.

Unit – III **08 Hrs**

Hydraulic circuit Design and Analysis: Control of a single acting cylinder, double acting cylinder, regenerative circuit, counter balance valve applications, Hydraulic cylinder sequencing circuits, automatic cylinder reciprocating systems, Locked cylinder using pilot check valves, cylinder synchronizing circuits, fail safe circuits.

Unit – IV **08 Hrs**

Pneumatic Concepts: Introduction, comparison of hydraulics/pneumatics/and electrical system, air compressor system, types of compressors, compressed air behavior, pneumatic actuators, direction control valves, building a pneumatic circuits, application of logic valves.

Design of Pneumatic Circuits: Speed control circuits, Application of time delay valves. Position sensing in pneumatic cylinders, roller lever valve, pressure sensing in pneumatic circuits, pressure sequence valve, two cylinder movement,cascade method.

Unit –V **08 Hrs**

Electro-Pneumatics: Introduction, Pilot operated solenoid valve, Electrical connection to the solenoid, Electro-pneumatic circuit, Electrical limit switches and proximity switches, Relays, Solenoid, PE converter, Concept of latching.

Servo Systemand PLC Applications in Pneumatics: Closed loop control with servo system, Hydro-mechanical servo system, Electro-hydraulic servo system, Conventional valve vs proportional valve, Proportional valve in hydraulic circuits, characteristics of proportional valve and servo valve. PLC application in fluid power, logic in ladder logic diagram and Mnemonics, Timer- on delay and off delay.

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

CO1:	Describe the constructional features of hydraulic and pneumatic components
CO2:	Apply hydraulic and pneumatic controls in the design of automated controls.
CO3:	Evaluate the design of hydraulic and pneumatic components for building a circuit
CO4:	Design the hydraulic and pneumatic based systems for industrial applications.

Reference Books

1	Introduction to Hydraulics and Pneumatics, S Ilango, V Soundararajan, PHI Publication, ISBN-978-81-203-3079-5.
2	Hydraulics and Pneumatics, Jagadeesha T, I K International Publication, ISBN: 978-93-84588-90-8

3	Introduction to fluid power, James L Johnson, Cengage Learning, First Edition 2003, ISBN- 981-243-661-8
4	Hydraulic and pneumatic controls, R Srinivasan, Tata McGraw hill, second edition,2010 ISBN – 978-81-8209-138-2

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

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

SEMESTER : I						
PRODUCT DATA MANAGEMENT (Professional Elective-B1)						
Course Code	**:**	**18MPD1B1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

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

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

CO1:	Understanding the Product data base systems
CO2:	Select the Product data base systems based on material and product
CO3:	Analyzing the Product data base and Product life cycle for new products
CO4:	Evaluate the parameters for Product data base considerations based on process

Reference Books

1	Implementing and Integrating Product Data Management and Software Configuration Management - 20 - Ivica Cmkovic Ulf Asklund - AnnitaPerssonDahlqvist - 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). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a

combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

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

SEMESTER : I						
INTELLIGENT SYSTEMS (Professional Elective-B2) (Common to CSE, MD, CIM)						
Course Code	**:**	**18MCE1B2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11 Hrs**

Overview of Artificial Intelligence: Artificial Intelligence and its Application areas;
Knowledge Representation and Search: The Predicate Calculus: The Propositional Calculus, The Predicate Calculus, Using Inference Rules to Produce Predicate Calculus Expressions, Application: A Logic-Based Financial Advisor;
Structures and strategies for state space search: Introduction, Structures for state space search ,Strategies for State Space Search, Using the State Space to Represent Reasoning with the Predicate Calculus; And/or Graphs.

Unit – II	**10 Hrs**

Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, The Best-First Search Algorithm, Admissibility, Monotonicity and Informedness, Using Heuristics in Games, Complexity Issues.
Control and Implementation of State Space Search: Introduction, Recursion-Based Search, Production Systems, The Blackboard Architecture for Problem Solving.

Unit – III	**10 Hrs**

Other Knowledge Representation Techniques: Semantic Networks, Conceptual Dependencies, Scripts and Frames, Conceptual Graphs.
Knowledge Intensive Problem Solving: Overview of Expert System Technology, Rule-Based Expert Systems, Model-Based, Case Based, and Hybrid Systems
Planning: Introduction to Planning, Algorithms as State-Space Search, Planning graphs.

Unit – IV	**10 Hrs**

Automated Reasoning: Introduction to Weak Methods in Theorem Proving, The General Problem Solver and Difference Tables, Resolution Theorem Proving;
Uncertain Knowledge and Reasoning:
Introduction to Uncertainty, Inference using Full-Joint Distribution, Independence, Bayes' Rule and its use.
Representing Knowledge in Uncertain Domain:
Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Network, Approximate Inference in Bayesian Network

Unit –V	**11 Hrs**

Introduction to Learning: Forms of Learning: Supervised learning, Unsupervised Learning, Semi-Supervised and Reinforcement Learning; Parametric Models & Non-Parametric Models, Classification and Regression problems
Artificial Neural Networks: ANN Structures, Single Layer feed-forward neural networks, Multi-Layer feed-forward neural networks, Learning in multilayer networks, networks.
Artificial Intelligence Current Trends : The Science of Intelligent Systems, AI: Current Challenges and Future Directions;

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

CO1	Explore various Artificial Intelligence problem solving techniques.
CO2	Identify and describe the different AI approaches such as Knowledge representation, Search strategies, learning techniques to solve uncertain imprecise, stochastic and nondeterministic nature in 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.	Artificial Intelligence – Structures and Strategies for Complex problem Solving, George F Luger, 6th Edition, Pearson Publication, 2009, ISBN-10: 0-321-54589-3, ISBN-13: 978-0-321-54589-3
2.	Artificial Intelligence A Modern Approach, Stuart Russel, Peter Norvig, 3rd Edition, Pearson Publication, 2015, ISBN-13: 978-93-325-4351-5
3.	Artificial Intelligence, Elaine Rich, Kevin Knight, 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709, ISBN-13: 978-0070087705
4.	Intelligent Systems-A Modern Approach, Grosan, Crina, Abraham, Ajith, Springer-Verlag Berlin Heidelberg 2011, ISBN 9783642269394, 2011.

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : I						
NON-TRADITIONAL MACHINING & TESTING (Professional Elective-B3)						
Course Code	**:**	**18MCM1B3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

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

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

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

Unit – II	**11 Hrs**

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

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

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

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

Unit – III	**11 Hrs**

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

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

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

Unit – IV	**10 Hrs**

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

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

Unit –V	**10 Hrs**

Non Destructive Testing: Scope and advantages of NDT, comparison of NDT with DT, classifications of NDT, introduction, principle, equipment, procedures and characteristics of Visual Inspection, Eddy Current Testing, Liquid Penetrant Testing, Magnetic Particle Testing and Radiographic Testing.	
Course Outcomes **After going through this course the student will be able to:**	
CO1:	Explain the principle, mechanism of metal removal of various unconventional machining processes.
CO2:	Analyses the process parameters and their effect on the component machined on various unconventional machining processes and tested using NDT techniques.
CO3:	Apply the concept for different NTM and NDT concepts industry.
CO4:	Evaluate appropriate NTM and non-destructive techniques.

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

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
Mechatronics in Manufacturing Systems (Theory and Practice)						
Course Code	**:**	**18MCM21**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 + 3Hrs**

Unit – I	**10 Hrs**

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.

Unit – II	**11 Hrs**

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.

Unit – III	**11 Hrs**

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.

Unit – IV	**10 Hrs**

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

Unit – V	**10 Hrs**

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.

UNIT-VI (Lab Component)	**2 Hrs/Week**

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.

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

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

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

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

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

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

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : II						
Tooling for Manufacturing in Automation						
Course Code	**:**	**18MCM22**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
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	
Unit – II	**08 Hrs**
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.	
Unit – III	**08 Hrs**
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.	
Unit – IV	**08 Hrs**
Machinability and Surface Integrity: Machinability, Chatter in Machining Operations, Milled Roundness, Machined Surface Texture, Machining Temperatures, Tool Wear and Life	
Unit – V	**08 Hrs**
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.	

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	Cutting Tool Technology- Industrial Handbook, Graham T. Smith, Springer.2 nd Ed, ISBN 978-1- 84800-204-3.
2	Tool Design, Cyrol Donaldson,, Tata McGraw Hill, , India, 4th Ed ISBN 0070992746.
3	Fundamentals of Tool Design, Edward G Hoffman, SME, USA. ISBN 0872634906
4	Metal cutting theory and practice, David A.Stephenson, John S. Agapiou, CRC Taylor and Francis publishers, 2nd Ed. ISBN 0824795792.

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

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

SEMESTER : II						
RESEARCH METHODOLOGY (Common to all programs)						
Course Code	**:**	**18IM23**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Overview of Research

Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.

Unit – II	**08 Hrs**

Data and data collection

Overview of probability and data typesPrimary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.

Sampling Methods: Probability sampling and Non-probability sampling

Unit – III	**08 Hrs**

Processing and analysis of Data

Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools

Unit – IV	**08 Hrs**

Advanced statistical analyses

Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.

Unit-V	**07 Hrs**

Essentials of Report writing and Ethical issues

Significance of Report Writing ,Different Steps in Writing Report,Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism

Case studies: Discussion of case studies specific to the domain area of specialization

Course Outcomes

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

CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

Reference Books:

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
MINOR PROJECT						
Course Code	**:**	**18MCE24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:2**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

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

Course Outcomes: After completing the 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
Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

Phase	Activity	Weightage
I	Synopsys 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 of Semester End Examination (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.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

SEMESTER : II						
AUTOMATION AND PRODUCTION SYSTEMS (Professional Elective-C1)						
Course Code	**:**	**18MCM2C1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
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.	
Unit – II	**11 Hrs**
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.	
Unit – III	**11 Hrs**
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.	
Unit – IV	**10 Hrs**
Storage Systems: Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated storage systems, Engineering Analysis of Storage System.	
Unit – V	**10 Hrs**
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	

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	Flexible manufacturing, David J Parrish, Butterworth-Heinemann Publisher, 1990 ISBN: 9780750610117
2	Automation, Production Systems and Computer Integrated Manufacturing, Mikell P Groover, Prentice Hall India (P) Ltd, 2008 ISBN: 9780132393218
3	Flexible Manufacturing Cells & Systems, William W. Luggen, Prentice hall, 2006, ISBN: 9780133217384
4	Modeling of Automated Manufacturing Systems, Viswanadham N, Narahari Y, Performance 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). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

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

Scheme of Semester End Examination (SEE) for 100 marks

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

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

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

Course Outcomes

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

CO1:	Explain the concept of DFMA and GD&T
CO2:	Apply engineering products and suggest suitable manufacturing process
CO3:	Evaluate the influence of design, material and manufacturing processes on product assembly
CO4:	Develop appropriate manufacturing and assembly processes for a given product

Reference Books

1	Product Design for Manufacture and Assembly,Geoffrey Boothroyd, Peter Dewhurst, Winston Knight Marcel Dekker, Inc., Newyork - Second Revision, ISBN 0-8247-0584-X
2	Designing for Manufacturing,Harry Peck, Pitman Publications,1983, ISBN: 1-85233-810-5
3	Dimensioning and Tolerance for Quantity Production, Merhyle F Spotts, Englewood Cliffs, Prentice Hall, 5th edition, ISBN: 2-95433-956-3
4	Design for manufacturing – a structured approach, CorradoColig, 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). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

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

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

Unit – I	**10 Hrs**

Points, lines and planar curves: Vector algebra

Shapes inside a computer: Review of geometry and trigonometry, Points in a plane: Position vectors, Angles between lines - introducing the third dimension: Scalar products, Finding normal to planes: Vector products, Following a line: Parameters

Unit – II	**11 Hrs**

Lines in space: Vector equations: Lines in two-dimensional space, in three-dimensional space, Different parametric forms; Lines and common curves: Parametric and Cartesian forms: Linearity and non-linearity, Functions, The parabola, The circle, The ellipse, The circular helix

Transformations: Matrix algebra, Tools for transformations: Matrices, Transformations, Matrices, Adding and subtracting matrices, Multiplying matrices; Moving in a plane: Scaling, reflection and rotation: Matrices as geometric operators, Scaling position vectors, Reflecting position vectors in the axes, Rotating position vectors about the origin, Transforming polygons

Unit – III	**11 Hrs**

Combining transformations: Translations, Order in combining transformations, Specific combinations of transformations, Translations, (3x3) Matrices for transformations in a plane Sizing things up: Homogeneous vectors: Simple homogeneous vectors, General homogeneous vectors, Matrix operations using homage vectors

Useful manoeuvres: Non-standard rotations and reflections the viewing transformation: Standard and standard, Rotation about an arbitrary point, Reflection in an arbitrary line, The viewing transformation

The third dimension: Moving along rays, points at infinity and three-dimensional transformations: Geometrical insights using homogeneous vectors, Completing consideration of (3*3) matrices, Points at infinity, Three dimensional transformations, Some specific (4x4) matrices, Local scaling, Reflections in the coordinate planes, Rotations about the coordinate axes, Translation, Overall scaling, In conclusion

Unit – IV	**10 Hrs**

Points of view: Projection and single point perspective: Projection from three dimensions onto a plane, Orthographic projection, The need for perspective, Single point perspective, Perspective projection, Tunnel perspective, To improve realism

A greater sense of perspective: Two point and three point perspective: Improving perspective, Translation then single point perspective, Rotation then single point perspective, giving two points perspective, Rotation, translation then single point perspective improved two point perspective, Two rotations, translation then single point perspective, giving three point perspective, The three types of perspective-projection, Vanishing points and trace points

Space curves and surfaces: Differentiation, Slopes of lines and planar curves: Gradient functions: Lines and curves, Slope of a straight line from its Cartesian equation, Slope of a curve from its Cartesian equation, Practical rules for differentiation, Slope of a straight line from its vector equations

Slopes of space curves: Tangents and normal, Space curves, The tangent vector to a space curve, Tangents and normals for curves in a plane, Tangents and normals in three dimensions

Unit – V	**10 Hrs**

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

Course Outcomes **After going through this course the student will be able to:**	
CO1:	Discuss the concepts of Computer Graphics in CAD in product development
CO2:	Apply the concepts of CAD in the manufacturing industry
CO3:	Analyze the concepts of computer Aided Design
CO4:	Evaluating the techniques involved in CAD

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
ADVANCED METROLOGY (Professional Elective-D1)						
Course Code	**:**	**18MCM2D1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

INTRODUCTION TO 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.

Unit – II	**11 Hrs**

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.

Unit – III	**11 Hrs**

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 displacmentmeasurments.

Unit – IV	**10 Hrs**

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.

Unit – V	**10 Hrs**

ADVANCES IN METROLOGY- MisionVision:Image Analysis and Computer Vision, Computer Vision Systems, Image Analysis Techniques, Digital Image Processing, Challenges in Image Processing-Image, Vision System for Measurement, ComparisionofLaser 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.

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	Engineering Metrology, Jain.R.K, Khanna Publishers, New Delhi, 2012.ISBN 13:9788174091536
2	Handbook of Optical Dimensional Metrology, Kevin G Harding, CRC Press, A Taylor& Francis group, 2013. ISBN: 9781439854815.
3	Coordinate, Measuring Machines and Systems, Robert.JHocken, Paulo H. Pereira,CRCPress,Taylor& Francis Group, 2011. ISBN:9781574446524.
4	Dimensional Metrology, Connie Dotson, 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). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
ROBOTICS & AUTOMATION (Professional Elective-D2)						
Course Code	**:**	**18MCM2D2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

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

Unit – II	**11 Hrs**

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

Unit – III	**11 Hrs**

Robotic Workspace & Motion Trajectory: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. Robotic Motion Trajectory Design: – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories: 4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.

Unit – IV	**10 Hrs**

Dynamics of Robotic Manipulators: Introduction, Bond Graph Modeling of Robotic Manipulators, Examples of Bond Graph Dynamic Modeling of Robotic Manipulator. Brief Discussion on Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Preliminary Definitions, Generalized Robotic Coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic Mass Distribution & Inertia Tensors, Newton's Equation, Euler Equations, The Lagrangian& Lagrange's Equations. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass, Dynamic Equations of Motion for A General Six Axis Manipulator.

Unit – V	**10 Hrs**

Autonomous Robot: Locomotion Introduction, Key issues for locomotion Legged Mobile Robots Leg configurations and stability Examples of legged robot locomotion Wheeled Mobile Robots Wheeled locomotion: the design space Wheeled locomotion: case studies Mobile Robot Kinematics Introduction Kinematic Models and Constraints Representing robot position Forward kinematic models Wheel kinematic constraints Robot kinematic constraints, Mobile Robot Maneuverability Degree of mobility Degree of steerability Robot maneuverability.

Course Outcomes

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

CO1:	Analyze the manipulator design including actuator, drive and sensor issues
CO2:	Calculate the forward kinematics, inverse kinematics and Jacobian industrial robots
CO3:	Solve trajectory and dynamic related robotic problems
CO4:	Evaluate the different configurations and stability of autonomous robots

Reference Books

1	A Robot Engineering Textbook, Mohsen ShahinpoorHarper & Row publishers, New York. ISBN:006045931X

2	Robotics, control vision and intelligence, Fu, Lee and Gonzalez, McGraw Hill International. ISBN:0070226253
3	Introduction to Robotics, John J. Craig, Addison Wesley Publishing, ISBN:0201543613
4	Autonomous mobile robots, Roland Illah R. SiegwartNourbakhsh, 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). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

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

SEMESTER : II						
SUPPLY CHAIN MANAGEMENT (Professional Elective-D3)						
Course Code	**:**	**18MCM2D3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

Introduction to 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.

Unit – II **11 Hrs**

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.

Unit – III **11 Hrs**

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.

Unit – IV **10 Hrs**

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.

Unit – V **10 Hrs**

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.

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	Designing & Managing the Supply Chain – Concepts Strategies and Case Studies, David Simchi

	Levi, Philip Kaminsky, Edith Simchi Levi & Ravi Shankar; Mc Graw Hill, 3rd Edition, 2008, ISBN: 978- 0-07-066698-6.
2	Supply Chain Management - Strategy, Planning & Operation", Sunil Chopra, Peter Meindl& D V Kalra: Pearson Education Asia; 5th Edition, 2013, ISBN: 978-0-13-274395-2.
3	Supply Chain Management – Creating Linkages for Faster Business Turnaround, Sarika Kulkarni & Ashok Sharma: TATA Mc Graw hill, 1st Edition, 2004, ISBN: 0-07-058135—5
4	Modelling the Supply Chain, Jeremy F Shapiro, Duxbury; 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). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

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

SEMESTER : II						
BUSINESS ANALYTICS (Global Elective-G01)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Business analytics

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

Unit – II **08 Hrs**

Trendiness and Regression Analysis

Modelling Relationships and Trends in Data, simple Linear Regression.Important Resources, Business Analytics Personnel, Data and models forBusiness analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit – III **08 Hrs**

Organization Structures of Business analytics

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

Unit – IV **08 Hrs**

Forecasting Techniques

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Unit –V **07 Hrs**

Decision Analysis

Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Course Outcomes

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

CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books

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

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)						
Course Code	**:**	**18CV2G02**		**CIE**	**:**	**100 Marks**
Credits L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**7 Hrs**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.	
UNIT – II	**9 Hrs**
Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.	
UNIT – III	**9 Hrs**
Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses:Stress-RelatedHealthIncidents,Eyestrain,RepetitiveMotion,LowerBackPain,VideoDisplay Terminals.	
UNIT – IV	**7 Hrs**
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii.Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	
UNIT – V	**7 Hrs**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.	

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.

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

Reference Books

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

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

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

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

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

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

SEMESTER : II						
MODELING USING LINEAR PROGRAMMING (Global Elective-G03)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

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

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

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

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
PROJECT MANAGEMENT (Global Elective-G04)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

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

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

CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books

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

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

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

SEMESTER : II						
ENERGY MANAGEMENT (Global Elective-G05)						
Course Code	**:**	**18CH2G05**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEEMarks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

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

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Understand the use alternate fuels for energy conversion
CO2	Develop a scheme for energy audit
CO3	Evaluate the factors affecting biomass energy conversion
CO4	Design a biogas plant for wet and dry feed

Reference Books

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

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
INDUSTRY 4.0 (Global Elective-G06)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

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

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

CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books

1	Industry 4.0 the Industrial Internet of Things, Alasdair Gilchrist, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, EmreCevikcan, Springer, 2018 ISBN 978-3-319-57869-9.
3	Designingtheindustry - Internet of things connecting the physical, digital and virtual worlds, OvidiuVermesan and Peer Friess, Rivers Publishers, 2016 ISBN978-87-93379-81-7
4	The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

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

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

SEMESTER : II						
ADVANCED MATERIALS (Global Elective-G07)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

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

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

CO1	Describe metallic and non metallic materials
CO2	Explain preparation of high strength Materials
CO3	Integrate knowledge of different types of advanced engineering Materials
CO4	Analyse problem and find appropriate solution for use of materials.

Reference Books

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

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

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

SEMESTER : II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Global Elective-08)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
CreditsL:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I — **08 Hrs**

Introduction to composite materials

Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particlereinforced
composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.

Unit – II — **08 Hrs**

Polymer matrix composites (PMC)

Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers,
Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**

Unit -III — **08 Hrs**

Ceramic matrix composites and special composites

Engineering ceramic materials – properties – advantages – limitations – monolithicceramics
– need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

Unit –IV — **07 Hrs**

Metal matrix composites

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgyprocess–diffusionbonding–stircasting–squeezecasting,asprayprocess,
Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries.

Unit –V — **08 Hrs**

Polymer nano composites

Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles.Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques.Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM.Mechanical and Rheological properties of Polymer Nano composites. Gas barrier,

Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.	
Course Outcomes **After completing the course, the students 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 list the choice ofmaterials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives forimportant engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nano-materials
Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd EditionSpringer-verlag Gmbh,2012 , ISBN: 978-0387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6thEdition- Cengage, Publishers,2013, ISBN: 13: 978-8131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, 2014,ISBN: 13: 978-0137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition,CRCPress-Taylor & Francis, 2010, ISBN: 10-9781498761666, 1498761666

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
PHYSICS OF MATERIALS (Global Elective-09)						
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Crystal Structure

Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg's law, Powder method, Bragg's spectrometer, Qualitative Analysis of Crystal structure using XRD, Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.

Unit – II **08 Hrs**

Dielectric Materials

Basic concepts, Langevin's Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polarizability as a function of frequency), Qualitative discussion of Internal Field and ClaussiusMossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect, Coupling factor, spontaneous polarization, Piezolelectricty in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.

Unit – III **08 Hrs**

Magnetic Materials

Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron and SQUID.

Unit – IV **07 Hrs**

Semiconducting Materials

Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement-quantum wires and dots, size dependent properties, Top down approach, Fabrication process by MillingandLithography,Bottomupapproach,fabricationprocessbyvapourphaseexpansionand vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.

Unit –V **08 Hrs**

Novel Materials

Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoeleasticity, Transformation hysteresis, Superelasticity, Characterization technique-Differntial Scanning calorimetry, Preparation technique- spin coating, Nitinol, CuAlNi alloy andapplications.

Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys, Carbon nanotubes, Graphene- Properties and Applications.

Course Outcomes

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

CO1	Apply the principles of Physics in Engineering.
CO2	Apply the knowledge of Physics for material analysis.
CO3	Identify and Analyze Engineering Problems to achieve practical solutions.
CO4	Develop solutions for Problems associated with Technologies.

Reference Books

1.	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN10-8122436978.
2.	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-780

3.	Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar, S Chand Publishing, Reprint 2015.
4.	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER : II						
ADVANCED STATISTICAL METHODS (Global Elective-G10)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

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

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

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

Reference Books

1.	Fundamentals of Statistics (Vol.I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.
2.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, John Wiley & Sons, 2014, ISBN:13 9781118539712, ISBN (BRV):9781118645062.
3.	Fundamentals of Mathematical Statistic-A Modern Approach, S.C. Gupta and V.K. Kapoor, 10th Edition, 2000, S Chand Publications, ISBN: 81-7014-791-3.

4.	Regression Analysis: Concepts and Applications, F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SYLLABUS
FOR
SEMESTER III & IV

SEMESTER : III

DIGITAL MANUFACTURING
(Theory)

Course Code	**:**	**18MCM31**		**CIE Marks**	**:**	**100**
CreditsL:T:P	**:**	**4:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L+26T**		**SEE Duration**	**:**	**3Hrs**

Unit – I **10 Hrs**

Introduction: Development of Manufacturing Engineering, Status of Digital Manufacturing, ResearchMethods, Architecture, Organization Model and Function Model of Digital Manufacturing System, Industrial Internet, Case studies

Design for Additive Manufacturing: Design for Manufacturing and Assembly, Core DFAM Concepts andObjectives, CAD Tools for AM, Synthesis Methods

Unit – II **10 Hrs**

Computing Manufacturing: Virtual Prototyping, Reverse Engineering, Application of Reverse Engineering,Discrete Model of Manufacturing Computing, Information Model of Manufacturing computing, Geometric Modeling in Manufacturing Computing, Computational Geometry

Manufacturing Informatics: Information Characteristics, Activities and Manufacturing Informatics,Integration, Sharing and Security of Manufacturing Information. Integration Model, Principle and Mechanism of Sharing Manufacturing Resources

Unit – III **12 Hrs**

Intelligent Manufacturing System: The Application of Sensor in the Processing Data Mining, Data MiningApplied to Digital Manufacturing, Knowledge Reasoning in Engineering Design, Intelligent Knowledge-Based Manufacturing System, Self-Learning of Manufacturing System, Adaptation of Manufacturing System, The Concepts and Features of Intelligent Manufacturing, Multi-Agent Manufacturing System.

Future Development of Digital Manufacturing Science: The Precision of Digital Manufacturing, TheExtremalization of Digital Manufacturing, The Environmental Protection of Digital Manufacturing.

Unit – IV **10 Hrs**

The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies,Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.

Cloud and Fog: M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework(IIAF), Data Management.

Unit – V **10 Hrs**

Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardwareand Software Technology, Industrial Applications of AR, Maintenance, Assembly, Collaborative Operations , Training.

Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The wayforward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.

Course Outcomes

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

CO1: Explain the working process and technology development in Digital Manufacturing

CO2: Apply the principles of DM in the manufacturing industry

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.	Fundamentals of Digital Manufacturing Science, Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, 2012.Springer ISBN 978-0-85729-564-4,
2.	Collabarative design and planning for digital manufacturing, Lihni Wang, Andrew Y.C. Nee, Springer Series, 2009, ISBN 998-1-84882-286-3
3.	Industry 4.0 The Industrial Internet of Things, Alasdair Gilchrist, A press Publisher, ISBN-13 (pbk): 978-1-4842-2046-7.
4.	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, Springer, 2018 ISBN 978-3-319-57869-9

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks

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

SEMESTER: III						
INTERNSHIP						
Course Code	**:**	**18MCE32**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1) The duration of the internship shall be for a period of 8 weeks on full time basis after II semester final exams and before the commencement of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.
7) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization : Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 -Activities of the Department
    - Chapter 3 - Tasks Performed : summaries the tasks performed during 8 week period
    - Chapter 4 – Reflections : Highlight specific technical and soft skills that you acquired during internship
    - References & Annexure

Course Outcomes

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

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

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

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and aninternal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER: III						
MAJOR PROJECT : PHASE-I						
Course Code	**:**	**18MCE33**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.
2. The total duration of the Major project Phase-I shall be for 16 weeks.
3. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.
4. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.
5. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.
6. Students have to complete Major Project Phase-I before starting Major Project Phase-II.
7. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

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

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

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

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

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

Scheme for Semester End Evaluation (SEE):

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

SEMESTER : III						
ADDITIVE MANUFACTURING (Professional Elective-E1)						
Course Code	**:**	**18MCM3E1**		**CIE Marks**	**:**	**100**
CreditsL:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Development of Additive Manufacturing Technology: Computer-Aided Design Technology,Associated Technologies, Classification of AM Processes, Metal Systems, Metal Systems, Hybrid Systems, Steps in Additive Manufacture, Maintenance of Equipment, Materials Handling Issues **Design for AM:** Application Areas, Vat Photopolymerization Processes, Materials, ReactionRates, Process Modeling, Vector Scan VP Machines, Two-Photon Vat Photopolymerization, Process Benefits and Drawbacks	
Unit – II	**10 Hrs**
Powder Bed Fusion Processes: Introduction, Materials, Powder Fusion Mechanisms, ProcessParameters and Modeling, Powder Handling, Laser, UV and IR; Process Benefits and Drawbacks. **Extrusion-Based Systems:** Introduction, Basic Principles, Plotting and Path Control, Fused DepositionModeling, Stereo lithography: Materials, Processes parameters, advantages and limitations.	
Unit – III	**10 Hrs**
Material and Binder Jetting: Evolution, Materials, Material Processing Fundamentals, MaterialJetting Machines, Process Benefits and drawbacks, binding materials and systems. **Sheet Lamination Processes: Introduction**, Materials, Processes, Ultrasonic AM, Directed Energy Deposition Processes, Material Delivery, DED Systems, Process Parameters	
Unit – IV	**10 Hrs**
Design for Additive Manufacturing: Design for Manufacturing and Assembly, AM UniqueCapabilities, Core DFAM Concepts and Objectives, CAD Tools for AM. **Applications for Additive Manufacture:** Introduction, The Use of AM to Support MedicalApplications, Aerospace and Automotive Applications.	
Unit – V	**12 Hrs**
Rapid Tooling: Introduction, Direct and Indirect AM tooling process; Production of Injection MoldingInserts, EDM Electrodes, Investment Casting and Other Systems, RTV Silicone Tooling, Calcium silicate based castable tooling. **Direct Digital Manufacturing:** Align Technology, Siemens and Phonak, Custom Footwear and OtherDDM Examples, DDM Drivers, Manufacturing Versus Prototyping, Cost Estimation, Cost Model, Build Time Model, Laser Scanning Vat Photopolymerization, , Life-Cycle Costing, Future of DDM	

Course Outcomes

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

CO1: Explain the working process and technology development of Additive Manufacturing.
CO2: Apply the principles of AM in manufacturing industry
CO3: Analyze the concepts of AM in Production Process
CO4: Evaluating the techniques involved in AM

Reference Books

1.	Additive Manufacturing Technologies, Ian Gibson, David Rosen, Brent Stucker, Springer, 2ndEdition. ISBN 978-1-4939-2112-6
2.	3D Printing and Additive Manufacturing, Principles and Applications, Chee Kai Chua, Kah Fai Leong, 4th Edition, ISBN 978-9-8145-7140-1
3.	Additive Manufacturing,Amit Bandyopadhyay,Susmita Bose, CRC Press 2015 ISBN9781482223590
4.	Collabarative design and planning for digital manufacturing, Lihni Wang, Andrew Y.C. Nee, Springer Series, 2009, ISBN 998-1-84882-286-3

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

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

SEMESTER : III						
SURFACE ENGINEERING (Professional Elective-E2)						
Course Code	**:**	**18MPD3E2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

Surface cleaning –classification, and selection of cleaning processes-alkaline cleaning, solvent coldcleaning and vapour degreasing, eemulsion cleaning, pickling and descaling
Tribology - surface degradation, wear and corrosion, types of wear, roles of friction and lubrication-overview of different forms of corrosion**.**

Unit – II	**12 Hrs**

Surface Engineering of ferrous and nonferrous materials: cast iron, carbon and alloy steels,aluminium and alloys, copper and alloys, magnesium and alloys. Nickel and alooys**,**
Conversion coatings : Chemical and electrochemical polishing, significance, specific examples,phosphate, chromating, chemical coloring, anodizing of aluminum alloys, thermo chemical processes - industrial practices.

Unit – III	**10 Hrs**

Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices,alloy plating, electro composite plating, electroless plating of copper, nickel phosphorous, nickel-boron;
Environmental protection issues; Environmental regulation of surface engineering, cadmiumelimination vapour degreasing alternatives, competent organic coating.

Unit – IV	**10Hrs**

Sputter technique –Methods, applications, plasma treatments, nitriding, carbonizing, boriding,titanising methods, applications
Laser coatings : Laser alloying, sources, variables, methods, applications, specific industrial applications

Unit – V	**10 Hrs**

Thermal spraying- techniques, advanced spraying techniques - plasma surfacing, D-Gun and highvelocity oxy-fuel processes,

Laser surface alloying and Cladding - specific industrial applications, tests for assessment of wearand corrosion behaviour

Course Outcomes
After going through this course the student will be able to:
CO1: Explain various forms of corrosion and basic concepts of surface engineering
CO2: Evaluate the different surface engineering processes with respect to industrial practices
CO3: Apply the knowledge of different spraying techniques in surface engineering
CO4: Analyse tests for assessment of wear and corrosion behavior.

Reference Books

1	Surface modification technologies - An Engineer's guide, Sudarshan T S,, Marcel Dekker, Newyork, ISBN 10: 0824780094, 1989
2	Electroplating and Other Surface Treatments - A Practical Guide, Varghese C.D, TMH, 0074604643 9780074604649, 1993
3	Surface Engineering Practice, Processes, Fundamentals and Applications in Corrosion and Wear, Strafford, K.N., Datta, P.K., and Gray, J.S., Ellis Harwood, ISBN *13*: 9780138780593 (1990).
4	Advanced Surface Coatings: A Hand book of Surface Engineering, Mathews, A., Spinger, ISBN 095328–7203 (1991).

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

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

SEMESTER : III						
ADVANCED MANUFACTURING PRACTICES (Professional Elective-E3)						
Course Code	**:**	**18MCM3E3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Credits	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit–I **10 Hrs**

Just in Time Production –Primary purpose, profit through cost reduction, elimination of overproduction, quality control, quality assurance, respect for humanity, flexible work force, JIT production adapting to changing production quantities, process layout for shortened lead Times, standardization of operation, automation.

Sequence and Scheduling Used by Suppliers: Monthly and daily Information. sequencedwithdrawal system by sequenced schedule table, problems and counter measures in applying the Kanban system to sub-contractors

Unit–II **10 Hrs**

Toyota Production System-The philosophy of TPS, basic frame work of TPS, Kanbans.Determining the number of Kanbans in Toyota Production System, Kanban number under constant quantity withdrawal system, constant cycle, non-constant quantity withdrawal system.

Kanban Systems- Supplier Kanban and the sequence schedule for use by suppliers - Laterreplenishment system by Kanban, Sequenced Withdrawal System and Circulation of the Supplier Kanban within Toyota. production smoothing in TPS, production planning, production smoothing, adaptability to demand fluctuations, sequencing method for the mixed model assembly line to realize smoothed production of goal**.**

Unit–III **12 Hrs**

Just-in-Time Production with Total Quality Control just in time concept, cutting lot sizes, cuttingset-up times, cutting purchase order costs, the JIT cause-Effect chain,

Quality Improvements: scrap/quality improvements, motivational effects, responsibility effects,small group improvement activities, withdrawal of buffer inventory, the total quality control concept.

Unit–IV **10 Hrs**

Total Quality Control-Introduction-Total Quality Control concepts, responsibility, learning fromthe west, TQC concepts categorized, goals, habit of improvement, perfection, basics, process control, easy to see quality control as facilitator, small lot sizes, housekeeping,

Scheduling: Capacity scheduling, daily machine checking, techniques and Aids, exposure ofproblems, fool proof devices, tools of analysis, QC circles, TQC in Japanese-owned US electronics plant, TQC in Japanese-owned automotive plants

Unit–V **10 Hrs**

Plant Configurations: Introduction-ultimate plant configuration, job shop fabrication, framewelding, forming frame parts from tubing, dedicated production lines, overlapped production, the daily schedule, forward linkage, physical merger of processes, adjacency,

Material Handling Systems: mixed models, automated production lines, pseudo robots, robots,CAD and manufacturing, conveyors and stacker cranes, automatic quality monitoring

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Course Outcomes

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

CO1: Explain the role of JIT, TPS and TQC strategies in production system
CO2: Analyze the various concepts of modern manufacturing practices
CO3: Apply the concepts of JIT and TPS in real time applications
CO4: Evaluate the various process requirement to decide the plant configuration

Reference Books:

1	Japanese Manufacturing Techniques, Richard Schonberger, Pearson Higher Education -

	ISBN:0029291003, 1982
2	An Integrated Approach To Just In Time, Yasuhiro Monden, Toyota Production system, CRC Press, 4th Edition, ISBN: 9781439820971, 2011
3	Simon & Schuster, Adult Lean Thinking, James Womack, ISBN: 0743249275, 2003.
4	The machine that changed the World - The story of Lean production, Harper Perennial edition published James P. Womack, Daniel T Jones, and Daniel Roos, ISBN-13: 978-0-7432-9979-4, 1991.

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

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

SEMESTER: IV						
MAJOR PROJECT: PHASE-II						
Course Code	**:**	**18MCE41**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:20**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Major Project Phase-II is continuation of Phase-I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.
4. It is mandatory for the student to present/publish the work in National/International conferences or Journals
5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

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

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning.

Scheme of Continuous Internal Examination (CIE)

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

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

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

Scheme for Semester End Evaluation (SEE):

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

Stage-1Report Evaluation

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

Stage-2Project Viva-voce

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

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

SEE procedure is as follows:

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

SEMESTER: IV						
TECHNICAL SEMINAR						
Course Code	**:**	**18MCE42**		**CIE Marks**	**:**	**50**
Credits L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**30 Mins**

GUIDELINES

1. The presentation shall be done by individual students.
2. The seminar topic shall be in the thrust areas of respective PG programs
3. The seminar topic could be complementary to the major project work
4. The student shall bring out the technological developments with sustainability and societal relevance.
5. Each student must submit both hard and soft copies of the presentation along with the report.
6. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

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

CO1: Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable.

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

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

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

Scheme for Semester End Evaluation (SEE):

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