RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
R.V. Vidyaniketan Post, Mysuru Road
Bengaluru – 560 059

Scheme and Syllabus of I & II Semesters
(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
PRODUCT DESIGN AND MANUFACTURING

DEPARTMENT OF
MECHANICAL ENGINEERING

INNER FRONT COVER PAGE

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

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Master of Technology (M.Tech)

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PRODUCT DESIGN AND MANUFACTURING

DEPARTMENT OF

MECHANICAL ENGINEERING

VISION

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

MISSION

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

Program Outcomes (PO)

M. Tech. in Product Design and Manufacturing graduates will be able to:

PO1: Independently carry out a research / investigation and development work to solve practical problems related to product design & manufacturing.

PO2: Write and present a substantial technical report / document in the field of product design & manufacturing.

PO3: Demonstrate a degree of mastery over the areas of product design. The mastery would be at a level higher than the requirements in the bachelor's in Mechanical Engineering

PO4: Use modern tools for the design and analysis of static and dynamic systems and mechanisms.

PO5: Adopt safety, ethical and environmental factors in product design and processes

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

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ABBREVIATIONS

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

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RV COLLEGE OF ENGINEERNG, BENGALURU-560 059
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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech in PRODUCT DESIGN AND MANUFACTURING

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18 MAT11A	Applied Mathematics	MAT	4	0	0	**4**
2	18 MPD12	Product Design & Development	ME	4	0	1	**5**
3	18MPD13	Finite Element Analysis	ME	4	0	1	**5**
4	18HSS14	Professional Skills Development	HSS	0	0	0	**0**
5	18XXX1AX	Elective – A	ME	3	1	0	**4**
6	18XXX1BX	Elective – B	ME/CSE	4	0	0	**4**
Total number of Credits				19	1	2	**22**
Total Number of Hours / Week							

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18 MPD 21	Robust Design	ME	4	0	1	**5**
2	18 MPD 22	Product Life Cycle Management	ME	3	1	0	**4**
3	18 IM 23	Research Methodology	IEM	3	0	0	**3**
4	18MPD24	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	1	3	**25**
Total Number of Hours / Week							

I Semester		
GROUP A: CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MPD1A1	Product Design for Quality
2.	18MMD1A2	Tribology
3.	18MCM1A3	Design of Hydraulic & Pneumatic Systems
GROUP B: CORE ELECTIVES		
1.	18MPD1B1	Product Data Management
2.	18MCE1B2	Intelligent Systems
3.	18MCM1B3	Non-Traditional Machining & Testing
II Semester		
GROUP C: CORE ELECTIVES		
1.	18 MPD 2C1	Creative Engineering
2.	18 MPD 2C2	Design for Manufacture and Assembly
3.	18 MPD 2C3	Reliability Engineering
GROUP D: CORE ELECTIVES		
1.	18 MPD 2D1	Product Cost Analysis & Optimization
2.	18 MCM2D2	Robotics & Automation
3.	18 MPD 2D3	Systems Engineering

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

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

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

Course Outcomes:

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

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

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

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

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

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

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

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

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

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

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

Semester: I						
PRODUCT DESIGN & DEVELOPMENT (Theory & Practice)						
Course Code	**:**	**18MPD12**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Design as a Discipline: Mass production and professional designers-quality of life- get more, pay less-cost reduction and higher sophistication- products of dynamic culture. **Product life cycle:** Various stages of product life cycle- design stage-manufacturing and marketing/ implementation- usage and maintenance- the death of a product. **Design phases:** Design methodology- formulation- idea rack- short listing and selecting TWO idea-detailing- prototype preparation.	
Unit – II	**11 Hrs**
User centred Design survey: Importance on problem formulation, primary focus on people, target domain, clients and users, interaction, integrated approach, kinds of knowledge, style and peer group, user centred feedback. **Need statement and Design requirements:** Need statement, guidance for designers, independent of physical embodiment, major requirements and articulation. **Specifications and Constraints:** Quantitative and qualitative specifications and constraints, design space, refinement of design space, side stepping, various approaches like engineering, architectural, hybrid.	
Unit – III	**11 Hrs**
Idea-Rack: Seeking several concepts, Usability considerations: flexibility, interdisciplinary design and interaction, design activities like original design, adaptive design, and variant design. Tools helpful in generating ideas like deep encounter, analogy, reversal, fusion of opposites, brainstorming, realizing new constraints. **Optimization configuration Exploration:** Conventional optimization vs configuration optimization, thumb rules, yield to nature's forces, light weight components, use of standard parts, design for manufacturing, material selection.	
Unit – IV	**10 Hrs**
Simplicity, Complexity and Richness: Axiom and KISS, value consideration, tools for simplification, simple and complex, richness, value for complexity. **Decision Making:** Indecision is a negative act, delegating responsibilities, decisions on scanty data, important elements of decision making like analysis, synthesis, emotions, intuitions, risk and management of failures.	
Unit – V	**10 Hrs**
Uncoupled, Decoupled and coupled designs: Functional domain and functional requirements, physical domain and design parameters, mathematical representation like design matrix and coupled design, uncoupled, decoupled. Additional expenditure. **Products static and Dynamic Societies:** Form, context and misfits, products of static societies, products of dynamic societies, products of dynamic cultures, short comings, comparison and middle path.	
Unit –VI Composites Lab	**26 Hrs**
1. Understanding of various CAD commands and creating simple objects 2. Understanding of holes, cuts and model tree relations 3. Creation shafts, rounds, chamfers and slots 4. Sketch Tools & Datum planes 5. Creation of objects by revolved features, patterns and copies, sweeps and blends 6. Creation of engineering drawing details such as dimensioning, sectional views, adding esthetics	

7. Assembling of part models using constraints
8. Assembly operations -part modifications, adding another assembly features –display.

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

CO1: Understand the design phases
CO2: Formulate need statement and specifications
CO3: Apply decision making statement
CO4: Learn Computer Aided Modelling concepts.

Reference Books:	
1	Product Design, Prashant Kumar,PHI Learning Pvt. Ltd.,2012, ISBN:978-81-203-4427-3
2	Product Design and Development, Karl.T.Ulrich, Steven D Eppinger, McGrawHill ,2000, ISBN-13: 978-0078029066
3	Product Design and Manufacturing, A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003. ISBN-13: 978-8120342828.
4	SOLIDWORKS 2018 for Designers, Sham Tickoo, CADCIM Technologies,16th revised Edition Paperback, 2018.

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

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

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

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

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

Semester: I						
FINITE ELEMENT ANALYSIS (Theory & 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 Hrs**

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**
TWO 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 noded triangular elements – four noded rectangular 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, TWO dimensional heat conduction, TWO 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 Composites Lab	**26 Hrs**
Part-II 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

Reference Books:	
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, Srpinger series, 2013, ISBN: 978-1-4471-4330-7

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

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

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

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

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

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

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

Course Outcomes:

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

CO1: Develop professional skill to suit the industry requirement.

CO2: Analyze problems using quantitative and reasoning skills

CO3: Develop leadership and interpersonal working skills.

CO4: Demonstrate verbal communication skills with appropriate body language.

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

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

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

Semester: I						
PRODUCT DESIGN FOR QUALITY (Group A: Core Elective)						
Course Code	**:**	**18MPD1A1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**36L+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, Field inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.	
Unit – IV	**08 Hrs**
Statistical Consideration In Product Design and Development Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution- Statistical Process control–Scatter diagrams – Multivariable charts.	
Unit – V	**08 Hrs**
Six Sigma – Overview, Basics and history of the approach for six sigma, Methodology and focus, the application of Six Sigma in production and in service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy.	

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

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

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

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

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

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

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

Course Outcomes:

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

CO1: 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	Lubrication of Bearings - Theoretical principles and design, Radzimovsky, Oxford press Company, 2000
2	Theory and practice of Lubrication for Engineers, 1. Dudley D.Fuller, New YorkCompany.1998
3	Principles and applications of Tribology, Moore, Pergamon press, 1975
4	Engineering Tribology, G W Stachowiak, A W Batchelor Elsevier publication 1993.

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

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

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

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

Course Outcomes:

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

CO1: Describe the constructional features of hydraulic and pneumatic components

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

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

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

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

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

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

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

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

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

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

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

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

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

Semester I						
INTELLIGENT SYSTEMS (Group B: Core Elective) (Common to CSE, MPD, 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.

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

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

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

Unit – I	**10 Hrs**

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

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

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

Unit – II	**11 Hrs**

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

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

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

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

Unit – III	**11 Hrs**

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

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

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

Unit – IV	**10 Hrs**

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

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

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

Course Outcomes:

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

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

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

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

CO4: Evaluate appropriate NTM and non-destructive techniques.

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

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

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

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

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

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

SECOND SEMESTER

Semester: II						
ROBUST DESIGN (Theory & Practice)						
Course Code	**:**	**18MPD21**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Quality by Experimental Design Quality, western and Taguchi quality philosophy, Elements of cost, Noise factors, causes of variation, Quadratic loss function and variation of quadratic loss functions. **Robust Design** Steps in robust design, parameter design and tolerance design, illustration through numerical problems	
Unit – II	**11 Hrs**
Experimental Design Factorial experiments, terminology, factors, levels, Interactions, treatment combination, randomization, 2-level experimental design for two factors and three factors, Examples **Higher level experiment design** Two factors and three factors, factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples	
Unit – III	**11 Hrs**
Measures of Variability: Measures of variability, Concept of confidence level, Statistical distributions: normal, log normal and Weibull distributions. Hypothesis testing, Probability plots, choice of sample size illustration through numerical examples **Analysis and interpretation of experimental data:** Measures of variability, Ranking method, column effect method and plotting method, Analysis of variance (ANOVA), in factorial experiments, Regression analysis, Mathematical models from experimental data, illustration through numerical examples.	
Unit – IV	**10 Hrs**
Taguchi's Orthogonal Arrays : Types of orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs, Column merging method, Branching design, Strategies for constructing orthogonal arrays. **Signal to Noise ratio (S-N Ratios):** Evaluation of sensitivity to noise, Signal to noise ratios for static problems, Smaller – the – better types, Nominal – the – better – type, larger – the- better – type. Illustrations through numerical examples.	
Unit – V	**10 Hrs**
Parameter Design and Tolerance Design: Parameter and tolerance design concepts, Taguchi's inner and outer arrays, Parameter design strategy, Tolerance design strategy, illustrations through numerical examples**.** **Reliability Improvement Through Robust Design:** Role of S-N ratios in reliability improvement, Case study; Illustrating the reliability improvement of routing process of a printed wiring boards using robust design concepts.	

Unit – VI Robust Design Lab	26 Hrs
Industrial application problems on ANOVA, Taguchi's two level and three level factorial design, central composite design, regression analysis, S/N ratios, Orthogonal arrays and multi response optimisation to be solved using MINITAB.	

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

CO1: Understand the fundamentals of Robust design principles and techniques
CO2: Develop the knowledge to analyze experimental data through design of experiments
CO3: Assess the engineering design concepts for stability, reliability and tolerances
CO4: Formulate mathematical models using robust design concepts

Reference Books:	
1	Quality Engineering using Robust Design - Madhav S. Phadake: Prentice Hall, Englewood Clifts, New Jersey 07632, 1989.
2	Design and analysis of experiments - Douglas Montgomery: Willey India Pvt. Ltd., V Ed., 2007.
3	Techniques for Quality Engineering - Phillip J. Ross: Taguchi 2nd edition. McGraw Hill Int. Ed., 1996.
4	Quality by Experimental Design - Thomas B. Barker - Marcel Dekker Inc ASQC Quality Press, 1985

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

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

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

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

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

Semester: II						
PRODUCT LIFE CYCLE MANAGEMENT						
Course Code	**:**	**18MPD22**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Product life cycle management– Need for PLM, Components of PLM, Product Data and Product workflow, Drivers for Change.	
Unit – II	**08 Hrs**
The PLM Strategy, Developing a PLM Strategy, A Five-step Process Strategy Identification and Selection, Strategy Elements, Implications of Strategy Elements, Policies,Strategy Analysis, Communicating the Strategy	
Unit – III	**08 Hrs**
Change Management for PLM, Configuration management, cost of design changes, schemes for concurrent engineering, Design for manufacturing and assembly, robust design, failure mode and effect-analysis	
Unit – IV	**08 Hrs**
Modeling, Current concepts, part design, sketching,use of datum's construction features, free ovulation, pattering, copying, and modifying features, reference standards for datum specification, Standards for Engineering data exchange	
Unit – V	**08 Hrs**
Tolerance mass property calculations, rapid prototyping and tooling, finite modeling and analysis, general procedure, analysis techniques, Finite element modeling. Applicability of FEM, Static analysis, thermal analysis, dynamic analysis.	

Course Outcomes:

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

CO1: Explain product life cycle management concepts.

CO2: Analyze schemes of concurrent engineering.

CO3: Appraise modeling and analysis concepts.

CO4: Adapt change management concepts.

Reference Books:	
1	Product Lifecycle Management Paradigm for century Product Realization - John Stark, Springer-Verlag, 21st, London, 3rd printing -2006, ISBN: 1-85233-810-5
2	Implementing and Integrating Product Data Management and Software Configuration Management, Crnkovic, Ivica; Asklund, Ulf; & Dahlqvist, Annita Persson, Artech House Publishers, 2003. ISBN 1580534988.
3	Product Lifecycle Management, Grieves, Michael, McGraw-Hill, 2006. ISBN 0071452303
4	PDM: Product Data Management, Rodger Burden, Ronnie Bishop, Mary Ellen Lucas, , Resource Publishing, 2003. ISBN 0970035225.

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

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

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

Course Outcomes:

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

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

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

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

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

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

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

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

Semester: II						
MINOR PROJECT						
Course Code	**:**	**18 MPD 24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**---**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

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

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

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

Scheme of Continuous Internal Examination (CIE)

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

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

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

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

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

Scheme for Semester End Evaluation (SEE):

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

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

Semester: II						
CREATIVE ENGINEERING (Group C: Core Elective)						
Course Code	**:**	**18MPD2C1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

INTRODUCTION

Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, technology and business on creativity, force field analysis, market pull & technology push, attribute of a creative person, creative thinking in groups, creating a creative climate.

CREATIVITY & PRODUCT DESIGN

Need or identification of a problem, market survey, data collection, review & analysis, problem definition, Kipling method, challenge statement, problem statement initial specifications,

Unit – II	**11 Hrs**

IDEA GENERATION

Brain storming, analogy technique or synectics, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making,

CREATIVE THINKING PROBLEM / OPPORTUNITY

Pictures of situation, environment, quantification, Heros, boundary conditions, record-discuss-clarify-verify, recording of ideas, evaluation of ideas, detail design, prototyping, product deployment, useful life assessment, recycling

Unit – III	**11 Hrs**

EMOTIONAL DESIGN

Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective- design by individual and design in groups, designs with personality – machines that senses emotions and induce emotions-Robots, personality products, products for games, fun, people and places; Simulation – dimensional or mathematical, virtual simulation, physical simulation, scale down models;

Unit – IV	**10 Hrs**

THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ)

Common features of good solutions – resolve contradiction, use available resource, increase the ideality, trade-off, inherent contradiction, 30 key TRIZ principles – multifunction, preliminary action, compensation, nested doll, blessing in disguise, segmentation, separation, regional influences, symmetry change, opaque & porous, inflate and deflate, color, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, equipotential, static & dynamic, continuous & intermittent, servo systems, smart systems, dimensions

Unit – V	**10 Hrs**

APPLICATION OF CEDA Approach: (a) Cooking stove for rural India; (b) utilizing solar energy; (c) water filtration systems; (d) automation in healthcare; (e) technologies for law enforcement; (f) application of robots to reduce human fatigue (g) Layout of berths in a railway coach

Course Outcomes:

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

CO1: Explain the steps involved in the creative thinking process

CO2: Apply the various techniques for stimulating creativity and innovation thinking

CO3: Analyze the techniques to design and develop new products.

CO4: Synthesize the creative design with analysis to develop new products

Reference Books:	
1	Creative Engineering Design Synthesis, Amaresh Chakrabarti, Springer, 2009
2	Rousing Creativity: Think New Now, Floyd Hurt, Crisp Publ Inc. 1999, ISBN 1560525479
3	Emotional Design, Donald A. Norman,Perseus Books Group New York , 2004, ISBN 123-1-118-027-6
4	Simplified TRIZ – II edn., Kalevi Rantanen & Ellen Domb, Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748

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

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

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

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

Course Outcomes:

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

CO1: Explain the concept of DFMA and GD&T

CO2: Apply engineering products and suggest suitable manufacturing process

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

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

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

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

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
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Semester: II						
RELIABILITY ENGINEERING (Group C: Core Elective)						
Course Code	**:**	**18 MPD 2C3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Basic Probability Theory: Basic concepts – Definitions of Reliability, Parameters and Reliability concepts, Rules for combining Probabilities of events, Failure Density and Distribution functions, Bernoulli's trials, Binomial distribution, Expected value and standard deviation for binomial distribution, Numericals **Introduction to Probability Distributions:** Normal, Poisson and Binomial distribution. **Control Charts**: Variable Chart – X Bar chart, R-chart and Sigma chart. Attribute Chart: P – Chart, nP Chart, C-Chart and U – Chart. Numericals.	
Unit – II	**11 Hrs**
Network Reliability Evaluation: Basic concepts – Evaluation of network Reliability and Unreliability, Series systems, Parallel systems, Series - Parallel systems, partially redundant systems – Types of redundancies - Evaluation of network Reliability Unreliability using conditional probability method – Paths based and cutset based approach – complete event tree and reduced event tree methods. Numericals	
Unit – III	**11 Hrs**
Acceptance Sampling and Failure Data Analysis: Fundamentals of acceptance sampling, types of acceptance sampling, OC Curve, AQL, LTPD, AOQL. Introduction to Failure data analysis, Failure Data, Quantitative measures, MTTF, MTBF, Bathtub Curve, Mean Life, Life Testing, Problems, Introduction to Failure Mode and Effect Analysis. Numericals. **Reliability Improvement and Allocation:** Difficulty in achieving reliability, Methods for improving reliability during design, Different techniques available to improve reliability, Optimization, Reliability-Cost trade off, Prediction and Analysis.	
Unit – IV	**10 Hrs**
Discrete Markov Chains & Continuous Markov Processes Basic concepts, Stochastic transitional Probability matrix, time dependent probability evaluation, Limiting State Probability evaluation, Absorbing states, Markov Processes-Modelling concepts, State space diagrams, time dependent reliability evaluation of single component repairable model, Evaluation of Limiting State Probabilities of TWO, two component repairable models – Frequency and duration concepts, Frequency balance approach. Numericals.	
Unit – V	**10 Hrs**
Reliability Life Testing Methods: Reliability Life Testing - Test time calculations, Burn-in testing, Acceptance testing, accelerated life testing and Experimental Design - Reliability Growth Testing - Growth process, Idealized growth curve and other growth modals. Goodness of Fit tests - Chi-square goodness of fit test, Bartlett's test for the expTWOntial distribution, Mann's test for the weibull distribution, Kolmogorov, smirnov test for normal and lognormal distributions and tests for the power law process model.	

Course Outcomes:

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

CO1: Explain the concepts of reliability and probability theory.

CO2: Evaluate network Reliability and Unreliability for systems.

CO3: Analyse the various sampling and failure data analysis for reliability improvement

CO4: Develop Reliability Life Testing Methods for a given model

Reference Books:	
1	Reliability Engineering - A K Govil - Prentice Hall – 1981.
2	Reliability Engineering - E. Balagurusamy, Tata McGraw Hill, 2003.
3	Reliability Evaluation of Engineering Systems - Roy Billinton and Ronald N. Allan, Reprinted in India B. S. Publications, 2007.
4	Concepts in Reliability Engineering- Srinath L S - Affiliated East-West Press Private Limited, New Delhi, India. – 1985.

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

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
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Semester: II						
PRODUCT COST ANALYSIS AND OPTIMIZATION (Group D: Core Elective)						
Course Code	**:**	**18MPD2D1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction: New products, New product strategy , Sequential Decision Process, Market definition and entry strategy, Idea generation, introduction to the design process, forecasting sales potential	
Unit – II	**11 Hrs**
Consumer Measurement process, Research Methods, Sampling, Attitude Scaling, Perceptual Mapping: Perceptual Positioning, Perceptual Maps and Analytical methods to Perceptual Maps Product Positioning : Preference in Product Positioning, Proactive Product Positioning, Benefit Segmentation, Managerial use of Preference Models	
Unit – III	**11 Hrs**
Manufacturing Planning: Selection of optimum process, standardization. Break even analysis-application and area of use -problems -multi - product analysis and Process planning. **Value Analysis**: Steps in selection, analysis and implementation, Selection of cutting speed for optimum cost - problems.	
Unit – IV	**10 Hrs**
Cost Accounting Cost estimation -difference -types -steps involved in cost estimation. Types of Cost: Cost Centres, Direct –indirect, material cost -direct indirect material cost Overhead cost Elements in overheads: Preparation of cost sheet, machine hour rate, apportioning methods Variance Analysis – Labour variance, Material variance and Overhead variance, Activity based costing - Introduction to target costing	
Unit – V	**10 Hrs**
Cost Calculation Cost calculation for machined compTWOnts, welding, casting, Sheet Metal and forged compTWOnts illustrations - calculation of sales cost. Launching the product: Launch Planning, Track Launching, Durable and Industrial Products.	

Course Outcomes:

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

CO1: Describe the Value Analysis and new product strategy

CO2: Apply suitable manufacturing process based on material and product

CO3: Analyzing the Cost Accounting machined compTWOnts for a given material

CO4: Evaluate the parameters for design considerations based on process

Reference Books:	
1	Design and Marketing of New Products, Glen L Urban, John R Hauser, Prentice Hall. New Jersey, 1980, ISBN : 40:0257-02-0001
2	Mechanical Estimating and Costing, T.R.Ranga and S C Sharma, Khanna Publishers- 2015. ISBN : 40:0257-02-0001
3	Cost management in the New Manufacturing Age, Yasuhiro Monden Productivity Press-1992, 1980, ISBN : 90:0777-02-0001
4	Technique for Value Analysis And Engineering, Miles Lewrence, McGraw Hill, New york-1972, ISBN : 65:0257-22-0004

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

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

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

Unit – I	**10 Hrs**
Automation and Robotics - Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies. Concepts and Model about Basic Control System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Control Approaches of Robots	
Unit – II	**11 Hrs**
Kinematics of Robot Manipulator: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation & Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation	
Unit – III	**11 Hrs**
Robotic Workspace & Motion Trajectory: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. Robotic Motion Trajectory Design: – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories: 4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.	
Unit – IV	**10 Hrs**
Dynamics of Robotic Manipulators: Introduction, Bond Graph Modeling of Robotic Manipulators, Examples of Bond Graph Dynamic Modeling of Robotic Manipulator. Brief Discussion on Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Preliminary Definitions, Generalized Robotic Coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic Mass Distribution & Inertia Tensors, Newton's Equation, Euler Equations, The Lagrangian& Lagrange's Equations. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass, Dynamic Equations of Motion for A General Six Axis Manipulator.	
Unit – V	**10 Hrs**
Autonomous Robot: Locomotion Introduction, Key issues for locomotion Legged Mobile Robots Leg configurations and stability Examples of legged robot locomotion Wheeled Mobile Robots Wheeled locomotion: the design space Wheeled locomotion: case studies Mobile Robot Kinematics Introduction Kinematic Models and Constraints Representing robot position Forward kinematic models Wheel kinematic constraints Robot kinematic constraints, Mobile Robot 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 Shahinpoor, Harper & Row publishers, New York. ISBN:006045931X
2	Robotics, control vision and intelligence, Fu, Lee and Gonzalez, McGraw Hill International. ISBN:0070226253
3	Introduction to Robotics, John J. Craig, Addison Wesley Publishing, ISBN:0201543613
4	Autonomous mobile robots, Roland Illah R. Siegwart Nourbakhsh, The MIT Press Cambridge, Massachusetts London, England, 2004.ISBN:0262015358

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

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

Semester: II						
SYSTEMS ENGINEERING (Group D: Core Elective)						
Course Code	**:**	**18MPD2D3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
System Engineering and the World of Modem System: Definition, Origin, Examples of Systems Requiring Systems engineering, System Engineering view point, System Engineering as a Profession, The power of System Engineering, Problems. **Structure of Complex Systems:** Systems building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** System Engineering through the system Life cycle, Evolutionary Characteristic of the development process, The system engineering method, Testing throughout system development, problems	
Unit – II	**11 Hrs**
S**ystem Engineering Management:** Managing system development and risks, Work break down structure (WBS), System Engineering Management Plane (SEMP), Risk Management, Organization of System Engineering Capability Maturity Assessment, System Engineering standards, Problems. **Needs Analysis:** Origination of a new system, Operation analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, Problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, Problems.	
Unit – III	**11 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept selection, Concept validation, System Development planning, System Functional Specification, Problems. **Advanced Development:** Reducing program risks, Requirement analysis, Functional analysis and Design. Prototype development, Development testing, Risk reduction, problems.	
Unit – IV	**10 Hrs**
Engineering Design: implementing the System Building blocks, Requirements analysis, Functional analysis and design, Concept design, Design validation, Configuration Management, Problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
Unit – V	**10 Hrs**
Production: System Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, Problems. **Operation and support:** Installing, maintenance and up grading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems	

Course Outcomes:
After going through this course the student will be able to:
CO1: Explain the role of Stake holders and their need in organizational system.
CO2: Develop and document the knowledge base for effective system engineering processes
CO3: Apply available tool, methods and technologies to support high technologysystems.
CO4: Create the framework for quality processes to ensure high reliability of systems.

Reference Books:	
1	System Engineering-Principles and Practic, Alexander Kossoakoff, William N Sweet, John Wiley & Sons, Inc, Edition: 2012, ISBN: 978-81-265-2453-2
2	Hand book of System Engineering And Management, Andrew P. Sage, William B. Rouse, John Wiley & sons, Inc., Edition: 1999, ISBN 0-471-15405-9
3	General System Theory: Foundation, Development, Application, Ludwig von Bertalanffy,Penguin University Books, 1973, Revised, ISBN: 0140600043, 9780140600049
4	System Engineering and analysis, Balanchard, B., and Febrycky, W.Saddle river, NJ, USA: Prentice Hall, 5th Edition, 2010

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

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

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

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

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

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

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

Course Outcomes:

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

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

CO2: Analyze various techniques for modelling and prediction.

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

CO4: Formulate decision problems to solve business applications

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CO2: Formulate and solve problems using Linear Programming methods.

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

CO4: Analyze solutions obtained through Linear Programming techniques.

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

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

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
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Semester: II						
PROJECT MANAGEMENT (Group G: Global Elective)						
Course Code	**:**	**18 IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

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

Course Outcomes:

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

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

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

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

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

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

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

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

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

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

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

CO1: Understand the use alternate fuels for energy conversion

CO2: Develop a scheme for energy audit

CO3: Evaluate the factors affecting biomass energy conversion

CO4: Design a biogas plant for wet and dry feed

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

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

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

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

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

Course Outcomes:

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

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

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

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

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

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

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

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

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

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

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

CO1: Describe metallic and non-metallic materials

CO2: Explain preparation of high strength Materials

CO3: Integrate knowledge of different types of advanced engineering Materials

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Course Outcomes:

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

CO1: Apply the principles of Physics in Engineering.

CO2: Apply the knowledge of Physics for material analysis.

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

CO4: Develop solutions for Problems associated with Technologies.

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

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

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

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

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

Course Outcomes:

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

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

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

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

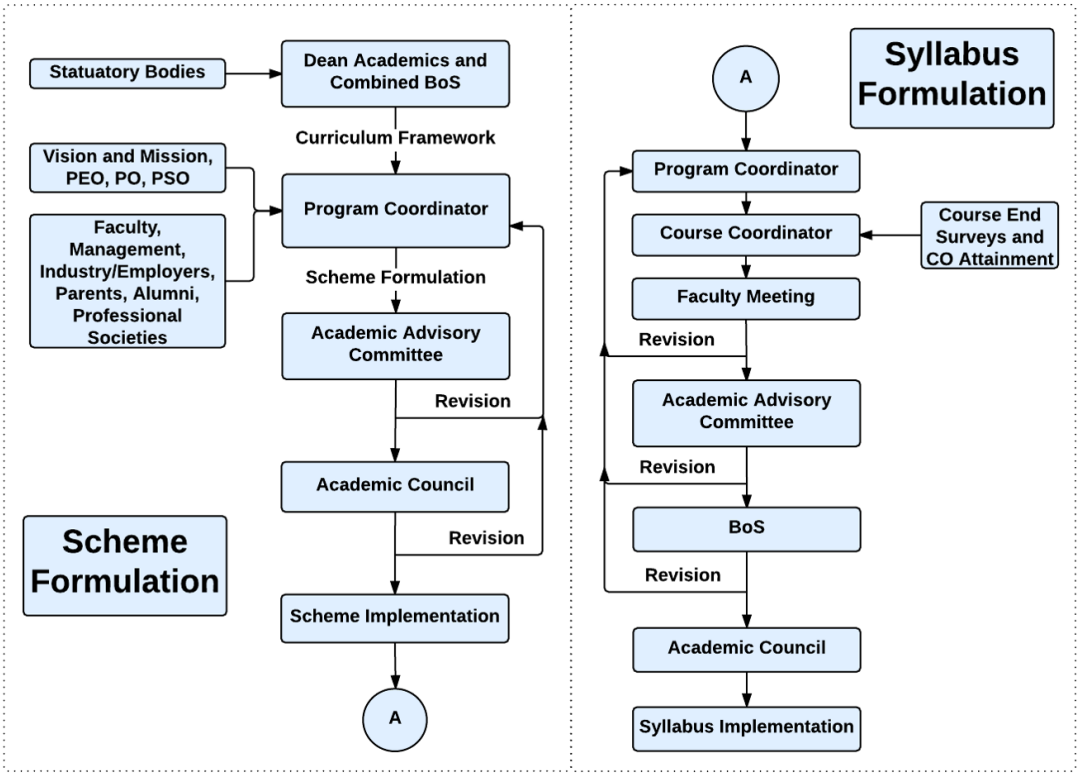
CO4: Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations

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

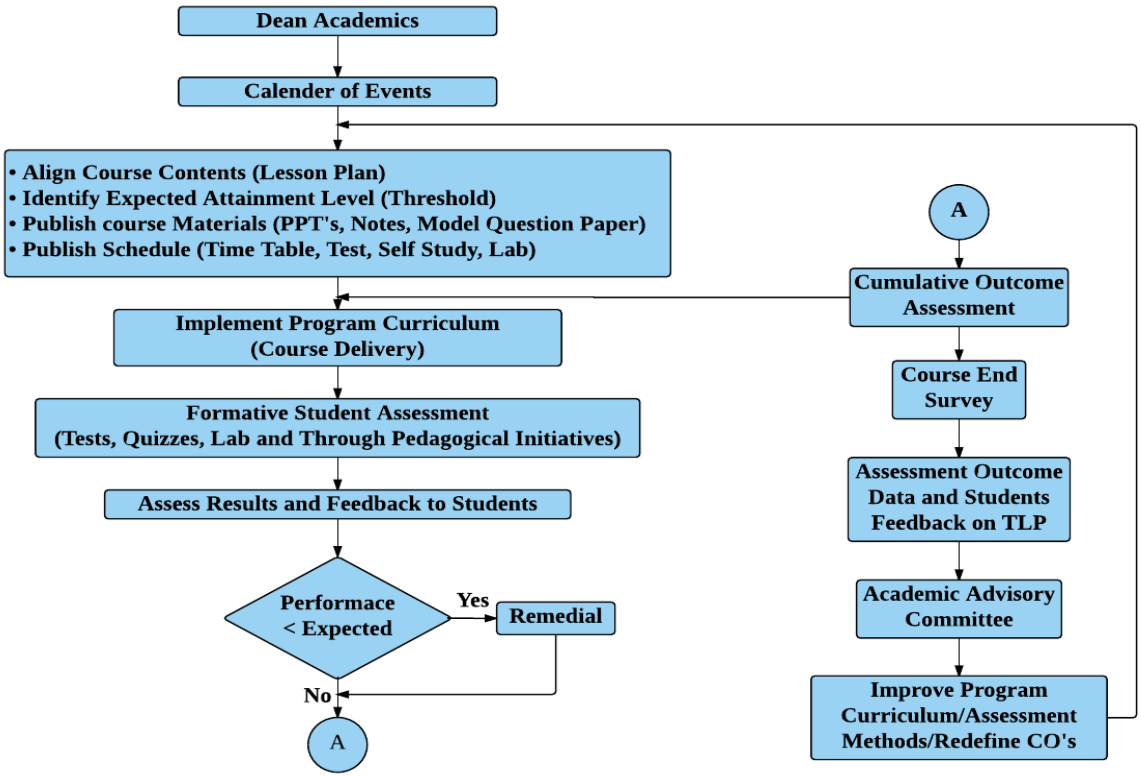
Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three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

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

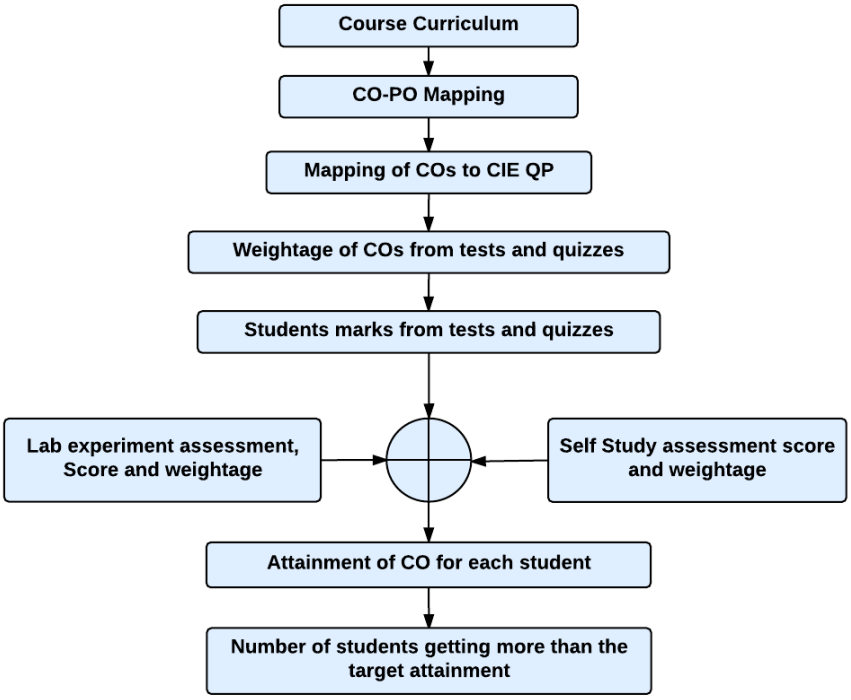
Curriculum Design Process



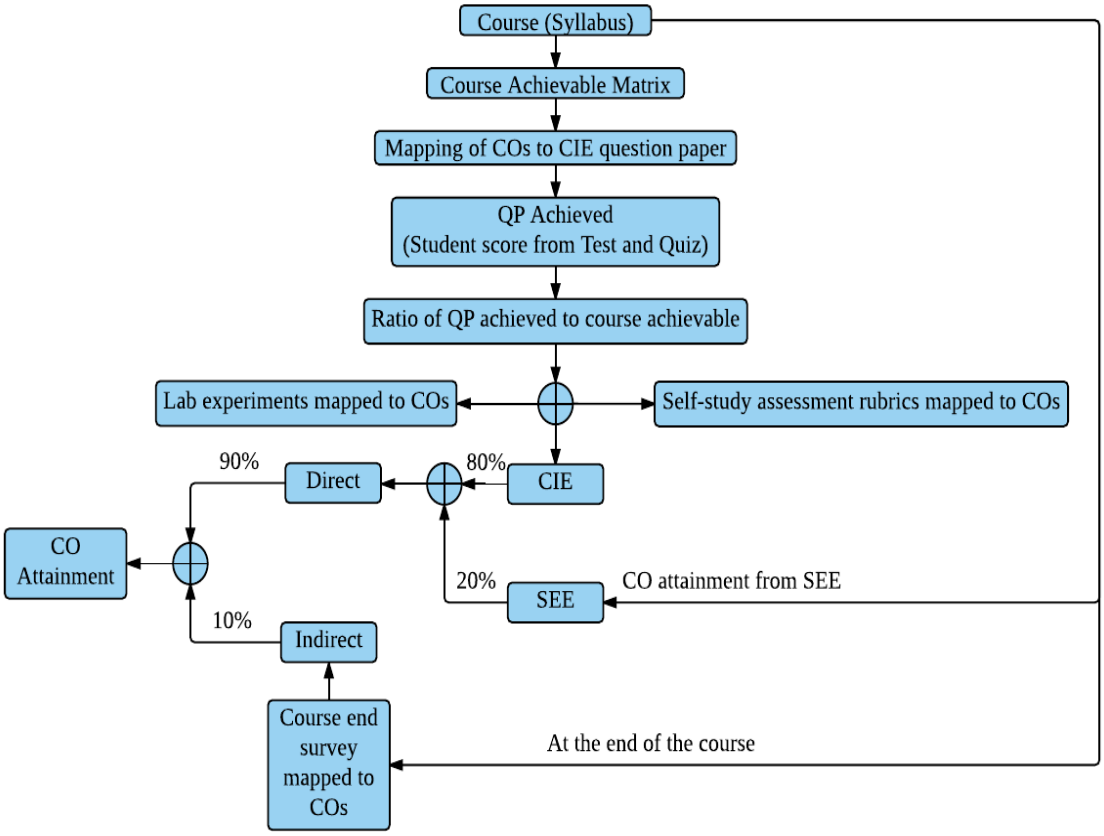
Academic Planning and Implementation



Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process