HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

(Approved by AICTE, New Delhi, Accredited by NAAC with 'A' Grade)

COIMBATORE 641 032

CHOICE BASED CREDIT SYSTEM

Revised Curriculum and Syllabus for the ODD and EVEN semester

Academic year 2023-24

VISION OF THE INSTITUTE

To become a premier institution by producing professionals with strong technical knowledge, innovative research skills and high ethical values.

MISSION OF THE INSTITUTE

- To provide academic excellence in technical education through novel teaching methods.
- To empower students with creative skills and leadership qualities.
- To produce dedicated professionals with social responsibility

VISION OF THE DEPARTMENT

To provide quality technical education in Mechanical Engineering and build holistic professionals who can excel in the engineering establishments and serve for the country with ethical values.

MISSION OF THE DEPARTMENT

M1: To prepare graduates with good technical skills and knowledge.

M2: To prepare graduates with life-long learning skills to meet the requirements in the higher education and in society.

M3: To prepare graduates as successful entrepreneur with employment skills, ethics and human values.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: Exhibit their sound theoretical, practical skills and knowledge for successful employments, higher studies, research and entrepreneurial assignments.

PEO 2: Lifelong learning skills, professional ethics and good communication capabilities along with entrepreneur skills and leadership, so that they can succeed in their life.

PEO 3: Become leaders and innovators by devising engineering solutions for social issues and problems, thus caring for the society.

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PROGRAMME OUTCOMES

Engineering graduates will able to

PO1. Engineering Knowledge: Apply the knowledge of Mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural societal, and environmental considerations.

PO4. Conduct investigations of complex problems: use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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PO11. Project management and finance: demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Lifelong learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

PSO1. Ability to become a successful entrepreneur caring for the society with ethical approach.

PSO2. Ability to pursue higher education in the field of engineering and management.

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CURRICULUM
2020

REGULATIONS - 2020
CHOICE BASED CREDIT SYSTEM
M.E. CAD/ CAM (FULL - TIME) CURRICULAM and SYLLABI
FOR I TO IV SEMESTERS
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1.	20MA1104	Applied Mathematics for Engineers	FC	3	1	0	4	40	60	100
2.	20CC1201	Computer Aided Design	PCC	3	0	1	3	40	60	100
3.	20CC1202	Integrated Mechanical Design	PCC	3	1	0	3	40	60	100
4.	20CC1203	Computer Aided Manufacturing	PCC	3	0	0	3	40	60	100
5.	20RM1153	Research Methodology and IPR	RMC	2	0	0	3	40	60	100
6.	20AC10XX	Audit Course – I*	AC	2	0	0	0	100	0	0
PRACTICALS										
7.	20CC1001	Computer Aided Design Lab	PCC	0	0	4	2	50	50	100
8.	20CC1002	Computer Aided Manufacturing Lab	PCC	0	0	4	2	50	50	100
			TOTAL	**16**	**2**	**9**	**20**			**700**

* Audit Course is optional.

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1.	20CC2201	Finite Element Analysis	PCC	3	1	0	4	40	60	100
2.	20CC2202	Integrated Product and Processes Development	PCC	3	1	0	3	40	60	100
3.	20CC2203	Design for Manufacture Assembly and Environment	PCC	3	0	0	3	40	60	100
4.	20CC23XX	Professional Elective I	PEC	3	0	0	3	40	60	100
5.	20CC23XX	Professional Elective II	PEC	3	0	0	3	40	60	100
6.	20CC20XX	Audit Course – II*	AC	2	0	0	0	100	0	0
PRACTICALS										
7.	20CC2001	Computer Aided Engineering Lab	PCC	0	0	4	2	50	50	100
8.	20CC2002	Inplant Training / Internship/ Mini Project	EEC	0	0	4	2	50	50	100
			TOTAL	**17**	**2**	**9**	**20**			**700**

* Audit Course is optional.

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1.	20CC33XX	Professional Elective III	PEC	3	0	0	3	40	60	100
2.	20CC33XX	Professional Elective IV	PEC	3	1	0	3	40	60	100
3.	20CC33XX	Professional Elective V/ Online Course	PEC	3	0	0	3	40	60	100
4.	20CC34XX	Open Elective / Online Course	OEC	3	0	0	3	40	60	100
PRACTICALS										
5.	20CC3901	Dissertation- I	EEC	0	0	12	6	50	50	100
			TOTAL	**12**	**1**	**12**	**18**			**500**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
PRACTICALS										
1.	20CC4901	Dissertation- II	EEC	0	0	24	12	100	100	200
			TOTAL	**0**	**0**	**24**	**12**			**200**

AUDIT COURSES (AC)
Registration for any of these courses is optional to students

AUDIT COURSES SEMESTER-I

SL.NO	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
1.	20AC1091	English for Research Paper Writing	2	0	0	0	100	0	0
2.	20AC1092	Disaster Management	2	0	0	0	100	0	0
3.	20AC1093	Sanskrit for Technical Knowledge	2	0	0	0	100	0	0
4.	20AC1094	Constitution of India	2	0	0	0	100	0	0
5.	20AC1095	Pedagogy Studies	2	0	0	0	100	0	0

AUDIT COURSES SEMESTER-II

SL.NO	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
1.	20AC2091	Value Education	2	0	0	0	100	0	0
2.	20AC2092	Stress Management by Yoga	2	0	0	0	100	0	0
3.	20AC2093	Personality Development through Life Enlightenment Skills	2	0	0	0	100	0	0
4.	20AC2094	Unnat Bharat Abhiyan	2	0	0	0	100	0	0

LIST OF ELECTIVES
SEMESTER II
ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
1.	20CC2301	Computer Aided Process Planning	PEC	3	0	0	3	40	60	100
2.	20CC2302	Additive Manufacturing	PEC	3	0	0	3	40	60	100
3.	20CC2303	Computer Integrated Production and Inventory Systems	PEC	3	0	0	3	40	60	100
4.	20CC2304	Design and Analysis of Experiments	PEC	3	0	0	3	40	60	100

ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
1.	20CC2305	Metrology and Non Destructive Testing	PEC	3	0	0	3	40	60	100
2.	20CC2306	Competitive Manufacturing Systems	PEC	3	0	0	3	40	60	100
3.	20CC2307	Design of Heat Exchanger	PEC	3	0	0	3	40	60	100
4.	20CC2308	Composite Materials and Mechanisms	PEC	3	0	0	3	40	60	100

SEMESTER III

ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
1.	20CC3301	Mechatronics Applications in Manufacturing	PEC	3	0	0	3	40	60	100
2.	20CC3302	Industrial Safety Management	PEC	3	0	0	3	40	60	100
3.	20CC3303	Supply Chain Management	PEC	3	0	0	3	40	60	100
4.	20CC3304	Industrial Robotics and Expert Systems	PEC	3	0	0	3	40	60	100

ELECTIVE IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
1.	20CC3305	Computational Fluid Dynamics	PEC	3	0	0	3	40	60	100
2.	20CC3306	Vibration Analysis and Control	PEC	3	0	0	3	40	60	100
3.	20CC3307	Optimization Techniques in Design	PEC	3	0	0	3	40	60	100
4.	20CC3308	Tribology in Design	PEC	3	0	0	3	40	60	100

ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
1.	20CC3309	Advanced Tool Design	PEC	3	0	0	3	40	60	100
2.	20CC3310	Manufacturing – Online Course Nptel/EDX/Mooc	PEC	3	0	0	3	40	60	100
3.	20CC3311	Design and Analysis of Thermal Energy Systems	PEC	3	0	0	3	40	60	100
4.	20CC3312	Basics and applications for Internet of Things	PEC	3	0	0	3	40	60	100

OPEN ELECTIVE COURSES [OEC]

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C	CIA	ESE	TOTAL
1.	20CC3401	Micro Electro Mechanical Systems	OEC	3	0	0	3	40	60	100
2.	20CC3402	Quality –Online Course NPTEL /EDX/ MOOC	OEC	3	0	0	3	40	60	100

Semester	I	II	III	IV	Total
Credits	20	20	18	12	70

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20MA1104	Applied Mathematics for Engineers	3	1	0	4

Course Objective

1. To provide information about Estimation theory, computational methods.
2. To impart knowledge Ordinary and partial differential equations and that will come in handy to solve numerically the problems that arise in engineering and technology.
3. To understand finite element method & simulation modelling
4. To Understand Cubic spline interpolation and Bezier curves.
5. To impart knowledge on numerical integration that will come in handy to solve numerically the problems

Unit	Description	Instructional Hours
I	**INTRODUCTION TO COMPUTATIONAL METHODS:** Solving set of equations - Gauss elimination method, LU-Choleski method, Gauss Jacobi method, Gauss Siedel method, successive over relaxation method, system of non-linear equations – Newton's method.	6+6
II	**NUMERICAL SOLUTION OF ODE & PDE:** Taylor series method, Euler and Modified Euler method (Heun's method), Runge Kutta method, Milne's method, Adams - Moulton method. Classification of partial differential equations of second order, Liebmann's method for Laplace equation and Poisson equation, explicit method and Crank-Nicolson method for parabolic equations, explicit method for hyperbolic equations	7+7
III	**FINITE ELEMENT METHOD & SIMULATION MODELLING:** The Rayleigh-Ritz method, Collocation and Galerkin method, finite element method – ordinary differential equations, elliptic, parabolic, hyperbolic partial differential equations.: Introduction, simulating deterministic behaviour, area under a curve, generating random numbers, simulating probabilistic behaviour, inventory model: gasoline and consumer demand.	9+9
IV	**INTERPOLATION:** (Revision – Forward, Backward, divided difference interpolation) - Cubic spline interpolation, Bezier curves and B-spline curves, polynomial approximation of surfaces, least square approximations.	4+4
V	**NUMERICAL INTEGRATION:** Gaussian quadrature, trapezoidal rule and Simpson's one third rule, multiple integrals, multiple integration with variable limits, application of cubic splines.	4+4
	Total Instructional Hours	**30+30**

Course Outcome

CO1: Students will able to know about Estimation theory, computational methods.
CO2. Able to use Ordinary and partial differential equations in real time problems.
CO3. It helps the students to get familiarized finite element method & simulation modelling
CO4. Able to solve Cubic spline interpolation and Bezier curves.
CO5. It helps the students to get familiarized numerical integration.

TEXT BOOKS:

T1.Curtis F Gerald and Patrick O Wheatly, "Applied Numerical Analysis", Pearson Education, New Delhi, 2011.

T2. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers with software and Programming Applications", Tata McGraw Hill, New Delhi, 2006.

T3. John H Mathews and Kurtis D Fink, "Numerical Methods using MATLAB", Prentice Hall, New Delhi. 2004.

REFERENCE BOOKS:

R1- Douglas J Faires and Richard Burden, "Numerical Methods", Cengage Learning, New Delhi, 2005.

R2. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Cengage Learning, New Delhi, 2013.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC1201	COMPUTER AIDED DESIGN	3	0	1	3

Course Objective

1. To acquire the knowledge on CAD/CAM software.
2. To familiarize about wireframe, surface and solid modeling techniques.
3. To enable the students to use the concepts of assembly and animation techniques.
4. To learn the techniques for Design applications.
5. To understand the principles of parametric, associative and feature based modeling concepts.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO CAD/CAM** Introduction, Product life cycle, CAD/CAM – Systems, applications, CAD – Methodology, uses, benefits, applications, 3D Modeling – Geometric models, coordinate systems. Sketching, parameters, dimensions, basic and datum features, geometric constraints, modeling operations.	9
II	**GEOMETRIC MODELING** Wireframe models - entities, Surface models - entities, representation, analytic surfaces, plane surface, ruled surface, surface of revolution, tabulated cylinder, synthetic surfaces, hermite bicubic surface, Bezier surface, B-spline surface, coons surface, blending surface, offset surface, triangular patches, surface manipulations, product data exchange.	9
III	**SOLID MODELLING** Solid models - entities, representation, Fundamentals of solid modeling, Basic elements and Building operations on boundary representation, constructive solid geometry and sweep representation, solid modeling based applications.	9
IV	**ASSEMBLY AND ANIMATION** Assembly modeling – Modeling, tree, planning, mating conditions, Bottom-Up assembly, Top-Down assembly, load options, managing and working, inference and orientation, analysis. Conventional and computer animation – Engineering animation, animation systems, animation types – frame buffer, real time playback and real time animation, key frame technique in animation, simulation technique.	9
V	**DESIGN APPLICATIONS** Limits and fits, Geometric tolerancing - datum's, types of geometric tolerances, drafting practices in dimensioning and tolerancing, design and engineering applications, finite element modeling.	9
	Total Instructional Hours	**45**

Course Outcome

Student shall be able to
CO1: Understand the concepts of wireframe, surface and solid modeling.
CO2: Assemble and create the mechanisms of components.
CO3: Familiarize in the concepts of geometric Dimensioning and Tolerance.
CO4: Execute the techniques of assemblage and animation.
CO5: Implement the concepts in applications of Design.

TEXT BOOKS:

T1- Ibrahim Zeid, "Mastering CAD/CAM" – McGraw Hill, International Edition, 2007.
T2- Dr.Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers – Fifth Edition.

REFERENCE BOOKS:

R1- William M Neumann and Robert F.Sproul "Principles of Computer Graphics", Mc Graw Hill Book Co. Singapore, 1989.
R2- Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw-Hill, 1998.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC1202	INTEGRATED MECHANICAL DESIGN	3	1	0	3

(Use of Approved Data Book Is Permitted)

Course Objective

1. To familiarize the various steps involved in the Design Process and to use standard practices and standard data.
2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
3. To learn the usage of catalogues and standard machine components.
4. To acquire the knowledge of factor of safety and design procedures.
5. To enable the students to work in design calculations.

Unit	Description	Instructional Hours
I	**FUNDAMENTALS AND DESIGN OF SHAFTS** Phases of design – Standardization and interchangeability of machine elements - Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO,DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix – Principal stresses – Maximum shear stress – Theories of Failure – Ductile vs. brittle component design -Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity.	12
II	**BRAKES** Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobiles and mechanical handling equipments.	12
III	**DESIGN OF GEARS** Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads– Component design of spur, helical, bevel and worm gears.	12
IV	**DESIGN OF GEAR BOX** Design for sub assembly –Integrated design of speed reducers and multi-speed gear boxes – application of software packages.	12
V	**INTEGRATED DESIGN** Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam & Follower, flywheel etc. Example - Design of Elevators and Escalators.	12
	Total Instructional Hours	**60**

Course Outcome

Student shall be able to

CO1: Understand the concepts of shaft and brake.

CO2: Design gear and gearbox components.

CO3: Understand the Integrated Design of Mechanical systems and Machines.

CO4: Execute the principles in real time problems.

CO5: Implement the concepts in automobile and automation components.

TEXT BOOKS:

T1- Norton L. Robert., "Machine Design – An Integrated Approach" Pearson Education, 2005.
T2- Newcomb T.P. and Spur R.T., "Automobile Brakes and Braking Systems", Chapman & Hall, 2nd Edition.

REFERENCE BOOKS:

R1- Shigley, J.E., "Mechanical Engineering Design", McGraw Hill, 1986.
R2- Prasad. L. V., "Machine Design", Tata McGraw Hill, New Delhi, 1992.
R3- Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.

APPROVED DATA BOOKS

1. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, 1983.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC1203	COMPUTER AIDED MANUFACTURING	3	0	0	3

Course Objective

1. To understand the principles of manufacturing and Numerical control Techniques.
2. To educate the students on CNC machine construction and its programming.
3. To familiarize the concept of advanced manufacturing techniques.
4. To know the principles of PDM and PLM concepts.
5. To enable the students to know the performance of CNC machines.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Objectives of a manufacturing system-identifying business opportunities and problems classification production systems-linking manufacturing strategy and systems analysis of manufacturing operations. Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Strategies, PDM & PLM.	9
II	**FUNDAMENTALS OF NUMERICAL CONTROL** Automation –Definition, Elements of CAM system, Product Development, Principles of Numerical control, Coordinate system for NC machine, Advantages and Limitations of NC ,CNC Technology, Types, Interpolation, Machine control unit, CNC Performance, Benefits, safety and Maintenance, DNC, Functions and Advantages.	9
III	**CONSTRUCTIONAL FEATURES OF CNC MACHINES** Design considerations of CNC machines for improving machining accuracy-Structural members-Slide ways-Sides linear bearings-Ball screws-Spindle drives and feed drives-work holding devices and tool holding devices-Automatic Tool changers. Feedback devices- Principles of Operation-Turning and Machining Centre's-Tooling for CNC machines.	9
IV	**PART PROGRAMMING FOR CNC MACHINES** Numerical control codes – Standards - Manual Programming - Canned cycles and subroutines-Computer Assisted Programming, CAD/CAM approach to NC part programming-APT language, machining from 3D models.	9
V	**ADVANCED CNC MACHINES AND MANUFACTURING** CNC grinders, CNC gear cutting machines, CNC wire cut EDM, CNC-CMM, CNC Molding Machines, Automated Welding, features of CAM packages, Tool path simulation, generation of NC code, Optimization of tool path using CAM software.	9
	Total Instructional Hours	**45**

Course Outcome

Student shall be able to
CO1: Select the appropriate code for performing particular task in a CNC machine.
CO2: Acquire the knowledge about constructional features of CNC machines.
CO3: Prepare the program for Turning and Milling operations.
CO4: Implement the Numerical control techniques in CNC machines.
CO5: Develop skills in tool path simulation, generation of NC code and tool path optimization.

TEXT BOOKS:

T1- Radhakrishnan.P, "Computer Numerical Control CNC machines" New central book agency, 2003.
T2- Mikell P.Groover, "Automation production systems and computer – integrated manufacturing", Prentice Hall of India. Ltd.,2008

REFERENCE BOOKS:

R1- Rao P.N., N.K. Tewari & T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill, 2001.
R2- Kant Vajpayee.S, "Principles of CIM", Prentice Hall of India, 1995.
R3- Dr.Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers – Fifth Edition.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20RM1153	RESEARCH METHODOLOGY AND IPR	2	0	0	3

Course Objective

1. To impart knowledge and skills required for research and IPR:
2. Problem formulation, analysis and solutions.
3. Technical paper writing / presentation without violating professional ethics
4. Patent drafting and filing patents.

Unit	Description	Instructional Hours
I	**RESEARCH PROBLEM FORMULATION** Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations	9
II	**LITERATURE REVIEW** Effective literature studies approaches, analysis, plagiarism, and research ethics.	9
III	**TECHNICALWRITING /PRESENTATION** Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.	9
IV	**INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)** Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	9
V	**INTELLECTUAL PROPERTY RIGHTS (IPR) 6** Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Ability to formulate research problem
CO2. Ability to carry out research analysis
CO3. Ability to follow research ethics
CO4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO5. Ability to understand about IPR and filing patents in R & D.

TEXT BOOKS:

T1- Asimov, "Introduction to Design", Prentice Hall, 1962.
T2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

REFERENCE BOOKS:

R1. Mayall, "Industrial Design", McGraw Hill, 1992.
R2. Niebel, "Product Design", McGraw Hill, 1974.
R3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC1001	COMPUTER AIDED DESIGN LAB	0	0	4	2

Course Objective

1. To provide hands on training to create surface, two and three dimensional modeling of machine components using modeling software.
2. To educate training to simulate various simple mechanisms.
3. To understand the design concepts of all components.
4. To familiarize information about bill of materials, limits and tolerances.
5. To gain knowledge in assembling top down and bottom up approach.

Unit	Description	Instructional Hours
1	Assembly modeling of the center lathe.	
2	Assembly modeling of fixture parts.	
3	Assembly modeling of IC engine components.	
4	Surface modeling of a vehicle parts.	
5	Sheet metal modeling of a container.	
6	Detailing of center lathe with bill of materials, limits and tolerances.	
7	Mechanism of IC engine components.	
	Total Instructional Hours	**30**

Course Outcome

Students shall be able to
CO1: Design the given machine components.
CO2: Assemble the machine components.
CO3: Detailing the given machine components.
CO4: Simulate the machine components.
CO5: know the concepts of modeling techniques.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC1002	COMPUTER AIDED MANUFACTURING LAB	0	0	4	2

Course Objective

1. To impart hands on training on CNC Machine tools, CMM and RPT.
2. To acquire practical knowledge through intensive practice on CNC Machines & related software.
3. To develop part programs for various components.
4. To create product using Rapid prototyping machine.
5. To know about the NC code generation.

Unit	Description	Instructional Hours
1	Manual part programming on CNC Lathe by using FANUC software.	
2	Manual part programming on CNC Milling and Drilling by using FANUC software.	
3	NC code generation for Lathe using CAM software.	
4	NC code generation for milling using CAM software.	
5	NC code generation for a component using CMM software.	
6	NC code generation in an Image Processing method for a component using CMM software.	
7	Prototype creation of a product using Rapid prototyping machine.	
	Total Instructional Hours	**30**

Course Outcome

Students develop ability in the following
CO1: Tool and machine setting.
CO2: CNC programming and tool path simulation.
CO3: Maintenance of CNC lathe and milling machine.
CO4: Hands on experience in CMM and RPT.
CO5: NC code generation.

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SEMESTER II

Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2201	FINITE ELEMENT ANALYSIS	3	1	0	4

Course Objective

1. To equip students with fundamentals of finite element principles so as to enable them to understand the behavior of various finite elements.
2. To select appropriate elements to solve physical and engineering problems with emphasis on structural and thermal engineering applications.
3. To provide the students with knowledge of the finite element method that will be of use in different manufacturing areas and to provide a foundation for further study.
4. To Develop code for one dimensional analysis and validation.
5. To learn higher order formulations for complex problems.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Basics of FEM – Initial value and boundary value problems – weighted residual Galerkin and Raleigh Ritz methods – review of Variational calculus – Integration by parts – Basics of variational formulation.	12
II	**ONE DIMENSIONAL ANALYSIS** Steps in FEA – Discretisation, function – derivation of element characteristics matrix, shape function, assembly and imposition of boundary conditions – solution and post processing – One dimensional analysis in solid mechanics and heat transfer.	12
III	**SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS** Global and Natural Co-ordinates – Shape functions for one and two dimensional elements – Three noded triangular and four noded quadrilateral element – Non linear analysis – Isoparametric elements – Jacobian matrices and transformations – Basics of two dimensional axi symmetric analysis.	12
IV	**ANALYSIS OF PRODUCTION PROCESSES** FE Analysis of metal casting – Special considerations, latent heat incorporation, gap element – time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure – Basic concepts of plasticity – Solid and flow formulation – small incremental deformation formulation – FE Analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.	12
V	**COMPUTER IMPLEMENTATION** Pre Processing, Mesh generation, elements connectivity, boundary conditions, input of material and processing characteristics – Solution and post processing – Overview of application packages such as ANSYS and DEFORM – Development of code for one dimensional analysis and validation.	12
	Total Instructional Hours	**60**

Course Outcome

Student shall able to
CO1: Develop Skills to select and use finite elements for different field problems like complex structure, heat transfer, vibration and fluid flow applications.
CO2: Acquire knowledge in one and two dimensional solutions.
CO3: Implement the FEM techniques in application packages such as ANSYS and DEFORM.
CO4: Create code for one dimensional analysis.
CO5: Execute the principles in real time problems.

TEXT BOOKS:

T1- Reddy, J.N, "An Introduction to the Finite element Method", McGraw – Hill, 1985.
T2- S.S.Rao, "The Finite Element Method in Engineering", Elsevier, Fifth Edition, 2011.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2202	INTEGRATED PRODUCT DESIGN AND PROCESSES DEVELOPMENT	3	1	0	3

Course Objective

1. To impart knowledge on product planning and product specifications, concept of selection and the product architecture.
2. To create expertise in the development of product and process.
3. To understand the product architecture and its implications.
4. To know the concepts of industrial and robust design.
5. To learn the techniques of product development.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Need for IPPD-Strategic importance of Planning and Product development – Generic development process, concept development, product development of process flow and organization, Customer needs.	12
II	**CONCEPT GENERATION, SELECTION AND TESTING** Plan and establish product specifications. Task - Structured approaches - clarification – search externally and internally-Explore systematically - reflect on the solutions and processes – concept selection - methodology - benefits. Implications - Product change - variety – component standardization - product performance - manufacturability – Concept Testing Methodologies.	12
III	**PRODUCT ARCHITECTURE** Implications of Architecture, establishing the architecture, Delayed differentiation, Platform planning- related system level design issues.	12
IV	**INDUSTRIAL AND ROBUST DESIGN** Need for industrial design, impact – design process, management of the industrial design process - assessing the quality of industrial design - Robust design.	12
V	**DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT** Definition - Estimation of Manufacturing cost-reducing the component costs, assembly costs and production costs- Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.	12
	Total Instructional Hours	**60**

Course Outcome

Student shall be able to

CO1: Define Integrated Product Teams, states their purpose, and describes how they are used to implement the concept of Integrated Product and Process Development.

CO2: Define Integrated Product and Process Development and describes the successful use of Integrated Product Teams by government Program Managers.

CO3: Acquire knowledge about product architecture.

CO4: know the industrial design and robust design techniques.

CO5: Execute the needs of the customer in global market.

TEXT BOOKS:

T1- Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999.

T2- Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book

REFERENCE BOOKS:

R1- Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992,

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2203	DESIGN FOR MANUFACTURE ASSEMBLY AND ENVIRONMENTS	3	0	0	3

Course Objective

1. To understand the principles of design such that the manufacturing of product is possible.
2. To educate students on various design aspects to be considered for manufacturing products using different processes.
3. To know the computer application in design for manufacturing and assembly.
4. To acquire the knowledge about global issues.
5. To provide information about economical design and recyclability.

Unit	Description	Instructional Hours
I	**INTRODUCTION** General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.	5
II	**FACTORS INFLUENCING FORM DESIGN** Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.	13
III	**COMPONENT DESIGN - MACHINING CONSIDERATION** Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machine ability - Design for economy - Design for clamp ability – Design for accessibility - Design for assembly.	8
IV	**COMPONENT DESIGN - CASTING CONSIDERATION** Redesign of castings based on parting line considerations - Minimizing core requirements, Machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.	10
V	**DESIGN FOR THE ENVIRONMENT** Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.	9
	Total Instructional Hours	**45**

Course Outcome

The students develop ability as indicated below:

CO1: Material selection based on Design, manufacturing process and assembly.
CO2: Application of DFMA tools for minimizing cost in manufacturing and efforts.
CO3: Designing of components based on environmental Factors.
CO4: Considerations in machining and casting to facilitate easy manufacturing.
CO5: Execute the principles in real time problems.

TEXT BOOKS:

T1- Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, MarcelDekker.
T2- Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.

REFERENCE BOOKS:

R1- Bralla, Design for Manufacture handbook, McGraw hill, 1999.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2001	COMPUTER AIDED ENGINEERING LAB	0	0	4	2

Course Objective

1. To provide hands on training on Finite Element Analysis software package for steady state and transient case for machine components.
2. To provide hands on training to simulate ANSYS APDL platform.
3. To acquire knowledge in ANSYS workbench platform.
4. To understand the concepts of computational fluid dynamics.
5. To enable the students to work with simulation techniques.

Unit	Description	Instructional Hours
1	Analysis of a structural truss with a point and UDL load using ANSYS classic platform.	
2	Analysis of a thermal plate with a mixed boundary (conduction / convection) using ANSYS classic platform.	
3	Modal analysis of a wind mill blade using ANSYS workbench platform.	
4	Transient analysis of a machine element under dynamic loads using ANSYS workbench platform.	
5	Analysis of a piston using ANSYS workbench platform.	
6	Analysis of a connecting rod ANSYS workbench platform.	
7	Analysis of a water flow in a pipeline using ANSYS Fluent.	
	Total Instructional Hours	**30**

Course Outcome

Students shall be able to
CO1: Select the method, meshing, analysis and optimize the given problem for structural, heat transfer and couple field applications.
CO2: Familiarize the concepts of simulation techniques.
CO3: Implement the techniques in real-time problems.
CO4: Prepare the report of finite element results.
CO5: Expose with various simulation software's.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2002	INPLANT TRAINING / INTERNSHIP	0	0	4	2

Course Objective

1. To familiarize students with real life situations in industrial organizations.
2. To accelerate the learning process.
3. To train the students to apply their gained knowledge in an Industrial organization.
4. To expose students with best working practices and with ethical values.
5. To inculcate integrity, responsibility, and self-confidence in student's mind.

Unit	Description	Instructional Hours

DURATION:

The students have to undergo practical Inplant Training / Internship for four weeks (During Second Semester holidays) in recognized industrial establishments/educational institutions / research and development organizations under the guidance of a faculty member. Periodically they have to communicate to the guide about the progress in the industry. At the end of the training they have to submit a project report with following information:

1. Profile of the Industry
2. Product range
3. Organization structure
4. Plant layout
5. Processes/Machines/Equipment/devices
6. Personnel welfare schemes
7. Details of the training undergone
8. Learning points.

II. The presentation of the above will be carried out during third semester.

Course Outcome

CO1: Describe structure of the Industrial organization.
CO2: Realize the various functions of management.
CO3: Understanding of groups and group dynamics.
CO4: Describe the industrial culture.
CO5: Develop skills to read, write and comprehend.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2002	MINI PROJECT	0	0	4	2

Course Objective

1. The main objective is to give an opportunity for the student to achieve integrated mechanical design of a product through parts design and assembly preparation of manufacturing drawings.
2. To learn the practical knowledge and skills in the field of Mechanical Engineering.
3. To get an experience and confidence level in a particular domain.
4. To train the students in preparing a project reports to face the reviews and viva examinations.
5. To identify a problem in the field of Mechanical Engineering and provide solutions, which are technically, economically and environmentally feasible.

Unit	Description	Instructional Hours
	GUIDELINE FOR REVIEW AND EVALUATION Each student's works under a project supervisor. The product system /component(s) to be designed may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the student which will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners.	
	Total Instructional Hours	**45**

Course Outcome

CO1: Identify the real world power system problems.
CO2: Analyze, design and implement solution methodologies.
CO3: Apply modern engineering tools for solution.
CO4: Write technical reports following professional ethics.
CO5: Able to analyze the current scenario in industries.

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SEMESTER – III

Programme	Course Code	Name of the Course	L	T	P	C
B.E	20CC3901	DISSERTATION I	0	0	12	6

OBJECTIVES:

The main objectives of the Project work Phase-I are:

- To identify a problem in the field of Mechanical Engineering and provide solutions, which are technically, economically and environmentally feasible.
- To train the students in preparing a project reports, presentations to face the reviews and final university viva examinations.

Project work assignment:

- Enable the students to form a convenient group with not more than four students.
- The project groups are assigned with a supervisor who is the faculty member of the respective department.
- In the case of industrial projects, one additional supervisor may be assigned as external supervisor.
- The students have to identify a technical problem related to the Mechanical Engineering based on the technical knowledge gained during the period of study.
- Four hours per week have been allotted in the time table.
- During project works, students can get the guidance from the supervisor(s), visiting library for literature review, conducting experiments related to the project work, computer simulation studies, field work, visiting industries (in the case of industry sponsored project works), case studies or basic research and development work assigned by the supervisor.
- The student has to make two presentations based on their project works.
- The solutions provided by the students should be technically, economically and environment friendly feasible.
- The project evaluation committee (constituted by the Head of Department) has evaluated the problem identification.
- The students has to consolidate the work as project report, which includes Introduction, Literature review, Modeling or simulation details, Experimental details, Results and discussions and Conclusions.
- The student should follow the guidelines for preparing the project work.

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SEMESTER – IV

Programme	Course Code	Name of the Course	L	T	P	C
B.E	20CC4901	DISSERTATION II	0	0	24	12

OBJECTIVES:

The main objectives of the Project work are:

- To learn the practical knowledge and skills in the field of Mechanical Engineering.
- To get an experience and confidence level in a particular domain.
- To train the students in preparing a project reports to face the reviews and viva examinations.

Project work assignment:

- Enable the students to form a convenient group of not more than four students and assigning them in a task involving theoretical and experimental studies related to Mechanical Engineering.
- The project groups are assigned with a supervisor who is the faculty member of the respective department. In the case of industrial projects, one additional supervisor may be assigned as external supervisor.
- Twelve hours per week have been allotted in the time table. The students can get the guidance from the supervisor(s), visiting library for literature review, conducting experiments related to the project work, computer simulation studies, field work, visiting industries (in the case of industry sponsored project works), case studies or basic research and development work assigned by the supervisor. Moreover, the student has to present three seminars based on the progress of their project works.
- The student has to apply his/her knowledge and skills to identify a suitable problem in the field of Mechanical Engineering and has to provide solutions, which are technically, economically and environment friendly feasible solution.
- The project evaluation committee (constituted by the Head of Department) has evaluated the project progress based on three reviews.
- The students has to consolidate the comprehensive review report, which includes Introduction (An Overview, Background and motivation, Objectives and methodology), Literature review (the studies reported during last ten years, problem identification and solution), Modeling or simulation details (equations used in the modeling, assumptions, specifications, details of the project work etc.), Experimental details (Description of experimental setup, instrumentation, experimental procedure), Results and discussions (comprehensive summary of experimental observations and discussions on improvements observed) and Conclusions (comprehensive summary of the major outcomes observed in the project work). The student should follow the guidelines for preparing the project work.

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List of Electives
Semester II - Elective I

Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2301	COMPUTER AIDED PROCESS PLANNING	3	0	0	3

Course Objective

1. To understand the principles of process planning for manufacturing the product.
2. To educate the students on various design aspects and process engineering.
3. To familiarize the students in computerized process planning and its integration.
4. To acquire knowledge in Geometric tolerance.
5. To learn the sequential and concurrent engineering concepts.

Unit	Description	Instructional Hours
I	**INTRODUCTION** The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning – Process Planning, sequential and Concurrent Engineering, CAPP.	9
II	**PART DESIGN REPRESENTATION** Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure- Geometric modeling for process planning.	9
III	**PROCESS ENGINEERING AND PROCESS PLANNING** Experienced, based planning - Decision table and decision trees - Process capability analysis - Process Planning - Variant process planning - Generative approach - Forward and Backward planning.	9
IV	**COMPUTER AIDED PROCESS PLANNING SYSTEMS** Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.	9
V	**AN INTERGRADED PROCESS PLANNING SYSTEMS** Totally integrated process planning systems - An Overview - Modulus structure - Data Structure, operation - Report Generation, Expert process planning.	9
	Total Instructional Hours	**45**

Course Outcome

Student shall be able to
CO1: Identify the process capabilities, such as process parameters, process boundaries, process performance and process cost in the areas of machining, mechanical and electronic assembly and circuit boards manufacturing.
CO2: Learn manual and computer aided process planning systems based on process planning criteria and implementation of economic considerations.
CO3: Prepare the Generative and Variant process planning approach.
CO4: Develop skills in preparing Decision table and decision trees.
CO5: Implement planning techniques with the help of MIPLAN, AUTOPLAN and PRO.

TEXT BOOKS:

T1- Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.
T2- Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.

REFERENCE BOOKS:

R1- Chang, T.C., “An Expert Process Planning System ", Prentice Hall, 1985.
R2- Nanua Singh, “Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.
R3- Rao, “Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2000.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2302	ADDITIVE MANUFACTURING	3	0	0	3

Course Objective

1. To educate the students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Art, Medical and industrial applications.
2. To impart knowledge in Reverse engineering concepts.
3. To learn about liquid and solid based additive manufacturing systems.
4. To understand the concepts of powder based additive manufacturing systems.
5. To know the techniques of 3D printing, SDM and BPM additive manufacturing systems.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits-Applications.	8
II	**REVERSE ENGINEERING AND CAD MODELING** Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.	10
III	**LIQUID AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS** Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.	10
IV	**POWDER BASED ADDITIVE MANUFACTURING SYSTEMS** Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.	10
V	**OTHER ADDITIVE MANUFACTURING SYSTEMS** Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.	7
	Total Instructional Hours	**45**

Course Outcome

Student shall be able to develop

CO1: Capability of creating two-dimensional and three-dimensional products and designs using appropriate tools, materials, methods and techniques.
CO2: Skill of applying prototype model in various disciplines.
CO3: Reverse engineering techniques.
CO4: Concepts of solid, liquid and powder based additive manufacturing systems.
CO5: Prototypes by using 3D printing, SDM and BPM additive manufacturing systems.

TEXT BOOKS:

T1- Gebhardt, A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
T2- Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

REFERENCE BOOKS:

R1- Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition,

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2303	COMPUTER INTEGRATED PRODUCTION AND INVENTORY SYSTEMS	3	0	0	3

Course Objective

1. To familiarize the student with current trends in production management activities.
2. To impress and prepare them to use modern technologies in future management systems.
3. To learn about aggregate and resource planning.
4. To impart knowledge about shop floor control.
5. To acquire computer process control and monitoring methods.

Unit	Description	Instructional Hours
I	**PRODUCTION PLANNING AND CONTROL AND FORECASTING** Introduction :Production Planning and Control-Traditional Production Planning and Control – Problems with Traditional Production Planning and Control-Computer-Integrated Production Management System-Engineering and manufacturing data base –Forecasting - Qualitative methods: Delphi technique, Market research, Intrinsic methods-Time series-moving averages-exponential smoothing- Extrinsic methods-regression-forecast errors-numerical problems.	9
II	**AGGREGATE PLANNING** Planning hierarchy-Aggregate production planning (APP)-need-Alternatives for managing supply and demand-basic strategies-numerical problems-APP methods-Master Production Scheduling.	8
III	**RESOURCE PLANNING** Inventory Management - Inventory types and general control procedures-Order point systems-The inventory management module- -Material Requirements Planning- Basic MRP Concepts-capacity requirements planning-Distribution requirements planning-Independent versus dependent demand-Lumpy demand-Lead times-Common use items-Inputs to MRP-numerical problems- Manufacturing Resource planning-Enterprise planning.	10
IV	**SHOP FLOOR CONTROL** Shop Floor Control -Functions of Shop Floor Control-Priority control and assignment of shop orders- Maintain information on work-in-process-Monitor shop order status-Production output data for capacity control-The Shop Floor Control System -Order release-Order scheduling-Order progress- Operation Scheduling-An overview of the scheduling problem-Priority rules for job sequencing-The Factory Data Collection System-Job traveler-Employee time sheet-Operation tear strips-Centralized shop terminal-Individual work center terminals-Voice data input.	9
V	**COMPUTER PROCESS MONITORING AND CONTROL** Computer Process Monitoring: Data logging systems-Data acquisition systems-Multilevel scanning-Computer Control: Computer-Process Interfacing-Manufacturing Process Data-System Interpretation of Process Data-Interface Hardware Devices-Digital Input/Output Processing Interrupt system - Control programming-Computer Process Control-Structural Model of a Manufacturing Process-Process Control Strategies-Distributed Control versus Central Control- Supervisory Computer Control.	9
	Total Instructional Hours	**45**

Course Outcome

Student shall be able to

CO1: Improve knowledge in failure modes and effect analysis.
CO2: Improve knowledge in accelerated testing concept.
CO3: Increase the software skill in reliability.
CO4: Prepare resource planning activities.
CO5: Execute the process control methods in industries.

TEXT BOOKS:

T1- Groover, M.P. and Zimmers, JR E.R.,"CAD/CAM: Computer-Aided Design and Manufacturing", Prentice Hall 1983.
T2- Mahapatra, P.B.," Computer-Aided Production Management", Prentice-Hall of India Pvt Ltd, 2004.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2304	DESIGN AND ANALYSIS OF EXPERIMENTS	3	0	0	3

Course Objective

1. To contextualise outputs where data are drawn from diverse and evolving social, political and cultural dimensions.
2. To reflect on experience and improve your own future practice.
3. To apply the principles of lifelong learning to any new challenge.
4. To bring together and flexibly apply knowledge to characterise, analyse and solve a wide range of problems.
5. To locate and use data and information and evaluate its quality with respect to its authority and relevance.

Unit	Description	Instructional Hours
I	**EXPERIMENTAL DESIGN FUNDAMENTALS** Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation, sample size, normal probability plot, and linear regression models.	6
II	**SINGLE FACTOR EXPERIMENTS** Completely randomized design, Randomized block design, Latin square design. Statistical analysis, estimation of model parameters, model adequacy checking, pair wise comparison tests.	9
III	**MULTIFACTOR EXPERIMENTS** Two and three factor full factorial experiments, Randomized block factorial design, Experiments with random factors, rules for expected mean squares, approximate F- tests. 2K factorial Experiments.	9
IV	**SPECIAL EXPERIMENTAL DESIGNS** Blocking and confounding in 2k designs. Two level Fractional factorial design, nested designs, Split plot design, Response Surface Methods.	9
V	**TAGUCHI METHODS** Steps in experimentation, design using Orthogonal Arrays, data analysis, Robust design- control and noise factors, S/N ratios, parameter design, Multi-level experiments, Multi-response optimization.	12
	Total Instructional Hours	**45**

Course Outcome

On completion of this course you should be able to:

CO1: Critically review basic concepts and models of experimental design.

CO2: Analyze the results of a designed experiment in order to conduct the appropriate statistical analysis of the data.

CO3: Interpret statistical results from an experiment and report them in non-technical language.

CO4: Prepare new solutions for existing issues.

CO5: Execute various method of solution in different areas.

TEXT BOOKS:

T1- Krishnaiah, K. and Shahabudeen, P. Applied Design of Experiments and Taguchi Methods, PHI learning private Ltd., 2012.

T2- Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, Eighth edition, 2012.

REFERENCE BOOKS:

R1- Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995.

R2- Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.

R3- Montgomery, D.C., Design and Analysis of Experiments, Minitab Manual, John Wiley and Sons, Seventh

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Semester II - ELECTIVE II

Programme	Course Code	Name of the Course	L	T	P	C
B.E	20CC2305	METROLOGY AND NON DESTRUCTIVE TESTING	3	0	0	3

Course Objective

1. To impart the knowledge of quality assurance and inspection techniques.
2. To familiarize with the various inspection and measurement techniques like contact and non-contact measurement by adapting Computer Aided Inspection.
3. To impart the knowledge of working principles and calibration of various Systems.
4. To study and understand the various non-destructive evaluation and testing methods, theory and their industrial applications.
5. To provide exposure to the students on various advanced measuring methods and nondestructive testing techniques.

Unit	Description	Instructional Hours
I	**MEASURING MACHINES** Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology.	9
II	**STATISTICAL QUALITY CONTROL** Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.	9
III	**LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS** Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.	9
IV	**RADIO GRAPHY** Sources of ray-x-ray production - properties of d and x rays - film characteristics – exposure charts - contrasts - operational characteristics of x ray equipment - applications.	9
V	**ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES** Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques – Advantages and limitations - Instrumentation - applications.	9
	Total Instructional Hours	**45**

Course Outcome

Students will be able to:

CO1: The student shall be able to understand the concept of Laser Metrology and Computer Integrated Machining Machine.

CO2: The student shall be able to understand the techniques used in statistical quality control.

CO3: The student shall be able to analysis the materials characteristics through various non-destructive tests.

CO4: The student shall be able to understand the knowledge various radiography characteristics and operations.

CO5: The student shall be able to understand the knowledge of ultrasonic and Acoustic emission techniques.

TEXT BOOKS:

1. Jain, R.K. “Engineering Metrology ", Khanna Publishers, 1997.
2. Barry Hull and Vernon John, "Non Destructive Testing ", MacMillan, 1988.

REFERENCE BOOKS:

1. American Society for Metals, “Metals Hand Book ", Vol.II, 1976.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2306	COMPETITIVE MANUFACTURING SYSTEMS	3	0	0	3

Course Objective

1. To understand the principles of manufacturing and flexible manufacturing systems.
2. To educate the students on Lean Green manufacturing systems.
3. To familiarize the concept of Just in time for manufacturing the products.
4. To understand the concepts of Green manufacturing systems.
5. To impart the knowledge of Automation and production system techniques.

Unit	Description	Instructional Hours
I	**AUTOMATION AND PRODUCTION SYSTEMS** Production system facilities, support systems, automation and manual labor in production systems, automation principles and strategies, manufacturing industries, products and operations, Components and classifications of manufacturing systems.	9
II	**GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS** Part families, classification and coding, production flow analysis, group technology applications and cellular manufacturing, Flexible manufacturing systems- components, applications, benefits, planning and implementation.	9
III	**LEAN MANUFACTURING** Origin of lean production system, customer focus, muda (waste),Standards – 5S system, Total productive maintenance, standardized work, man power reduction, overall efficiency, kaizen , common layouts, Jidoka concept, Poka-Yoke (mistake proofing),Worker Involvement, quality circle activity, kaizen training, suggestion programmes, oshin planning system (systematic planning methodology), lean culture.	9
IV	**JUST IN TIME** JIT – Definitions, approach, elements, effects, pull and push systems, KANBAN, MRP II, quality management system, plant layout, product design, purchasing, implementation, automation and benefits.	9
V	**GREEN MANUFACTURING** Impact of manufacturing in environment, role of manufacturing sector in national growth, technological change and evolving risk, Principles of green manufacturing , green manufacturing efficiency and its sustainability , green manufacturing strategies, motivation, barriers, advantages and limitations, Standards for green manufacturing.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Students can understand the concept of various Production and flexible manufacturing systems.
CO2: Enhance the ability of students to create GT code for a given product and differentiate the different types of products.
CO3: Create capability to manufacture different products with minimum defects using lean principles.
CO4: Student can understand the concepts of Just in time and Green Manufacturing approach.
CO5: Able to prepare a well planned schedule for production in industries.

TEXT BOOKS:

T1- Groover M.P., “Automation, Production Systems and Computer Integrated Manufacturing”, Third Edition, Prentice-Hall, 2007.
T2- Dr.Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers – Fifth Edition.

REFERENCE BOOKS:

R1- Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.
R2- Jha.N.K. “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	20CC2307	Design of Heat Exchanger	3	0	0	3

Course Objective

1. To expose the students about the classification of heat exchangers and its applications.
2. To know the factors considered for flow and stress analysis.
3. To develop skills for evaluate the sizing of heat exchangers.
4. To impart the knowledge on phase change heat exchangers.
5. To enable the students to design condenser and Colling tower

Unit	Description	Instructional Hours
I	**FUNDAMENTALS OF HEAT EXCHANGER** Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method.	9
II	**FLOW AND STRESS ANALYSIS** Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures.	9
III	**DESIGN ASPECTS** Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe - finned tube - shell and tube heat exchangers - simulation of heat exchangers.	9
IV	**COMPACT AND PLATE HEAT EXCHANGERS** Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters - limitations.	9
V	**CONDENSERS AND COOLING TOWERS** Design of surface and evaporative condensers – cooling tower – performance characteristics.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the syllabus student able to:
CO1: Understand the Industrial applications of heat exchangers.
CO2: Design the process heat exchanger.
CO3: Design the cooling towers, condensers, and evaporators.
CO4: To perform flow and stress analysis.
CO5: To do thermal design including phase change heat transfer.

TEXT BOOKS:

T1- Arthur P. Frass, Heat Exchanger Design, John Wiley & Sons, 1988.
T2- Hewitt G.F., Shires G.L. and Bott T.R., Process Heat Transfer, CRC Press, 1994.
T3- TaborekT., Hewitt.G.F. and Afgan N., Heat Exchangers, Theory and Practice, McGraw-Hill Book Co. 1980.

REFERENCE BOOKS:

R1- SadikKakac and Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, 2002.
R2- Sekulic D.P., Fundamentals of Heat Exchanger Design, John Wiley, 2003 .
R3-Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC2308	COMPOSITE MATERIALS AND MECHANISMS	3	0	0	3

Course Objective

1. To understand the fundamentals of composite material strength and its mechanical behavior.
2. Understanding the analysis of fiber reinforced Laminate design for different structures.
3. Combinations of plies with different orientations of the fiber.
4. Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
5. Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses.

Unit	Description	Instructional Hours
I	**LAMINA CONSTITUTIVE RELATIONS** Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic And Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke‟s Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes	12
II	**FLAT PLATE LAMINATE CONSTITUTE EQUATIONS** Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.	10
III	**LAMINA STRENGTH ANALYSIS** Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill‟s Criterion for Anisotropic materials. Tsai-Hill‟s Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure.	5
IV	**THERMAL ANALYSIS** Assumption of Constant C.T.E‟s. Modification of Hooke‟s Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E‟s. C.T.E‟s for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.	8
V	**ANALYSIS OF LAMINATED FLAT PLATES** Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.	10
	Total Instructional Hours	**45**

Course Outcome

CO1: Able to analyses the fiber reinforced Laminate for optimum design.
CO2: Apply classical laminate theory to study and analyses the residual stresses in Laminate.
CO3: To familiarize the concepts of Thermal Analysis.
CO4: To Implement various analyses in the real time problems.
CO5: To execute mechanisms of various Manufacturing Processes.

TEXT BOOKS:

T1- Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRC press in progress, 1994, -.

T2- Hyer, M.W., “Stress Analysis of Fiber – Reinforced Composite Materials”, McGraw Hill, 1998.

REFERENCE BOOKS:

R1- Issac M. Daniel and Ori Ishai, “Engineering Mechanics of Composite Materials”, Oxford University Press-2006, First Indian Edition – 2007.

R2- Mallick, P.K. and Newman, S., (edition), “Composite Materials Technology: Processes and

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SEMESTER III - ELECTIVE III

Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3301	**MECHATRONICS APPLICATIONS IN MANUFACTURING**	3	0	0	3

Course Objective

1. To provide overview of various electrical and electronic control techniques used in modern manufacturing systems.
2. To know the basic working principle of sensors and transducers of use for manufacturing systems
3. To know the basic working principle of drives and actuators of use for manufacturing systems
4. To know the features, modules and interfaces of microcontrollers and microprocessors
5. To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems

Unit	Description	Instructional Hours
I	**NTRODUCTION TO MECHATRONICS IN MODERN MANUFACTURING** Introduction to Process Parameters in Conventional Manufacturing – Assembly – Inspection – Transportation - Introduction to Systems - Subsystems of Mechatronics - Identification of Mechatronics' Entities in Modern Manufacturing - Mechanical, Fluid, Thermal, Electrical, Electronics, Communication, Control systems and Software Integration for Manufacturing - Classification of Manufacturing based on Mechatronics – CNC based Subtractive Manufacturing – Rapid Prototyping based Additive Manufacturing- Automated Assembly Stations – Modern Quality Inspection and Transportation Systems.	12
II	**SENSORS AND TRANSDUCERS** Introduction – Performance Terminology – Resistive Transducers – Inductive Transducers - Capacitance Transducers – Optical Sensors – Contact and Non-Contact Temperature Sensors – Eddy Current Sensor – Hall Effect Sensor – Piezo Electric Sensor - Ultrasonic Sensors – Proximity Sensors – Chemical and Gas Sensors - Signal Conditioning - Condition Monitoring	8
III	**DRIVES AND ACTUATORS** Role of Linear and Rotary Actuators - Electrical Actuators- Servo Concepts and Stepper Motors - Fluid Power – Piezo Actuators – Solenoids - Function of Drives - Mechanical Switching Devices – Solid State drives for various actuators	8
IV	**MICROPROCESSORS AND MICROCONTROLLERS** Requirement for Processor – Comparison of 8085 Microprocessor and 8051 Microcontrollers– 8051 Microcontrollers Architecture -Assembly Language Programming- Instruction Set, Addressing Modes, Basic Programming – Interfacing - Sensors, Keyboard, LED, LCD, A/D and D/A Converters, Actuators – Embedded Systems	8
V	**INTEGRATION OF MANUFACTURING SYSTEMS** Design Process - Stages of Design Process – Skeletal Structure and Block Diagram of CNC Based - Vertical Machining Centre, turning centre, Water Jet Machine, Electrical Discharge Machine, Serial Manipulator, hydraulic press, 3 D printers– Coordinate Measuring Machine –Automated conveyors - Extended Transportation System – Total Integration of Manufacturing Systems for Production Automation	9
	Total Instructional Hours	**45**

Course Outcome

CO1 : Imply the knowledge to study the mechatronics in modern manufacturing systems.
CO2 : Identify and select the sensors and transducers based on the application.
CO3 : Identify the principles and functions of drives and actuators.
CO4 : Get knowledge of microprocessor and microcontrollers and its functions.
CO5 : Apply the knowledge about integration of mechatronic systems in manufacturing.

TEXT BOOKS:

T1. Beno Benhabib, Manufacturing, design, production, automation and integration, Marcel Dekker, 2003
T2. Bolton W, — Mechatronics: Electronic control systems in mechanical and electrical engineering, 6thedition, Pearson Education Limited, 2015.

REFERENCE BOOKS:

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3302	INDUSTRIAL SAFETY MANAGEMENT	3	0	0	3

Course Objective

1. To eliminate accidents causing work stoppage and production loss.
2. To reduce workman's compensation, insurance rate and all the cost of accidents.
3. To educate all members regarding the safety principles to avoid accidents in industry.
4. To achieve better morale of the industrial employees.
5. To increase production means to a higher standard of living.

Unit	Description	Instructional Hours
I	**SAFETY MANAGEMENT** Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity.	9
II	**OPERATIONAL SAFETY** Hot metal Operation - Boiler, pressure vessels - heat treatment shop - gas furnace operation - electroplating-hot bending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machine shop - Cold bending and chamfering of pipes - metal cutting - shot blasting, grinding, painting - power press and other machines.	9
III	**SAFETY MEASURES** Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments, on- site and off site. Control of major industrial hazards.	9
IV	**ACCIDENT PREVENTION** Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees - First Aid- Fire fighting devices - Accident reporting, investigation.	9
V	**SAFETY, HEALTH, WELFARE & LAWS** Safety and health standards - Industrial hygiene - occupational diseases prevention - Welfare facilities - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.	9
	Total Instructional Hours	**45**

Course Outcome

At the end of this course, the students will have knowledge about:

CO1: Process safety management (PSM).
CO2: Maintenance principles and procedures.
CO3: Inspection engineering principles, procedures and instruments.
CO4: Safety in laboratories.
CO5: Hazards due to noise principles, measurement, safe limits and protective.

TEXT BOOKS:

T1-John V. Grimaldi and Rollin H.Simonds, "Safety Management", All India Travellers bookseller, Delhi-1989.
T2-Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996.

REFERENCE BOOKS:

R1- Managing emergencies in industries, Loss Prevention of India Ltd., Proceedings, 1999.
R2- Safety security and risk management by U.K. Singh & J.M. Dewan, A.P.H. Publishing Company, New Delhi, 1996.
R3-Occupational Safety Manual BHEL.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3303	SUPPLY CHAIN MANAGEMENT	3	0	0	3

Course Objective

To provide the student with the knowledge of,
1. Logistics management, network design, sourcing, pricing, coordination and technology in supply chain management.
2. Customer service performance improvement.
3. Reduction of pre & post production inventory.
4. Flexible planning and control procedures.
5. Product Quantity control.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Definition of Logistics and SCM: Evaluation, Scope Importance & Decision phases – Drivers of SC performance and Obstacles.	6
II	**LOGISTICS MANAGEMENT** Factors – Modes of transportation – Design options for transportation Networks - Routing and Scheduling – Inbound and outbound logistics –Reverse Logistics – 3PL – Integrated Logistics concepts- Integrated Logistics Model – Activities – Measuring logistics cost and performance – Warehouse Management – Case Analysis.	10
III	**SUPPLY CHAIN NETWORK DESIGN** Distribution in supply chain – Factors in Distribution network design – design Options – Network Design in supply chain – Framework for network Decisions – Managing cycle inventory and safety.	10
IV	**SOURCING AND PRICING IN SUPPLY CHAIN** Supplier Selection and contracts – design collaboration – Procurement process. Revenue management in supply chain.	9
V	**COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN** Supply Chain Coordination – Bullwhip effect of lack of Coordination and obstacles – IT and SCM – supply Chain IT frame work. E Business & SCM. Metrics for SC performance – Case Analysis.	10
	Total Instructional Hours	**45**

Course Outcome

CO1: At the end of this course the student should be able to manage logistics and supply chain of a factory or an organization.
CO2: Solving supplier's problems and beyond level.
CO3: Minimizing variance by means of activities like standardization, variety reduction, etc.
CO4: Attain Minimum total cost of operation & procurement.
CO5: Achieving maximum efficiency in using labour, capital & plant through the company.

TEXT BOOKS:

T1- Chopra, S. and Meindl, P., "Supply chain management, Strategy, Planning, and Operation ", PHI, Second edition, 2004.
T2- Christopher, M., "Logistics and Supply Chain Management – Strategies for Reducing Cost and Improving Service", Pearson Education Asia, Second Edition.

REFERENCE BOOKS:

R1- Bloomberg, D.J., Lemay, S. and Hanna, J.B.,'Logistics", PHI 2002.
R2- Shapiro, J.F. and Duxbury, T., "Modeling the supply Chain", 2002.
R3- Ayers, J.B., "Handbook of Supply Chain Management", Taylor and Francis Group, 2006.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3304	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	3	0	0	3

Course Objective

1. To understand the applications and concept of future trends in robotics.
2. To learn robot kinematics and its anatomy.
3. To acquire the knowledge of robot drives and control.
4. To educate about robot sensors and artificial intelligence.
5. To impart knowledge of robot programming.

Unit	Description	Instructional Hours
I	**INTRODUCTION AND ROBOT KINEMATICS** Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.	10
II	**ROBOT DRIVES AND CONTROL** Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.	9
III	**ROBOT SENSORS** Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.	9
IV	**ROBOT CELL DESIGN AND APPLICATION** Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.	9
V	**ROBOT PROGRAMMING AND ARTIFICIAL INTELLIGENCE** Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.	8
	Total Instructional Hours	**45**

Course Outcome

Students shall be able to

CO1: Understand about robot kinematics and dynamics.
CO2: Write basic program to control robot.
CO3: Understand about various sensors used in robotics field.
CO4: Prepare robot cell layout.
CO5: Execute the mechanism of robots.

TEXT BOOKS:

T1- Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
T2- Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.

REFERENCE BOOKS:

R1- Fu .K.S., R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
R2- Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.
R3- Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated

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SEMESTER III - ELECTIVE IV

Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3305	COMPUTATIONAL FLUID DYNAMICS	3	1	0	3

Course Objective

1. To develop finite difference and finite volume discretization forms of the CFD equations.
2. To formulate explicit & implicit algorithms for solving the Euler and Navier Stokes Eqns.
3. To understand the concepts of modes of heat transfer.
4. To impart knowledge about turbulence models.
5. To educate the compressible and incompressible flow techniques.

Unit	Description	Instructional Hours
I	**GOVERNING DIFFERENTIAL EQUATION AND FDM** Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.	10
II	**CONDUCTION HEAT TRANSFER** Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.	10
III	**INCOMPRESSIBLE FLUID FLOW** Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.	10
IV	**CONVECTION HEAT TRANSFER AND FEM** Steady One-Dimensional and Two-Dimensional Convection – diffusion, unsteady one dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM.	10
V	**TURBULENCE MODELS** Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.	5
	Total Instructional Hours	**45**

Course Outcome

Students shall be able to

CO1: Understand about compressible and incompressible flow fluids.
CO2: Select the governing equations for conduction and convection fluid flow applications.
CO3: Acquire knowledge about grid generation, processing and applications of CFD.
CO4: Develop skills in finite element modeling techniques.
CO5: Execute the principles in real time thermal and fluid problems.

TEXT BOOKS:

T1- Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
T2- Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.

REFERENCE BOOKS:

R1- Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
R2- Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer " Hemisphere Publishing Corporation, New York, USA,1984.
R3- Bose, T.X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3306	VIBRATION ANALYSIS AND CONTROL	3	1	0	3

Course Objective

1. To understand the fundamentals of vibration and its practical applications.
2. To understand the working principle and operations of various vibration measuring instruments.
3. To expertise in vibration measurements and control.
4. To acquire knowledge of degrees of freedom.
5. To educate about experimental methods.

Unit	Description	Instructional Hours
I	**FUNDAMENTALS OF VIBRATION** Undammed Free Vibrations: Single Degrees of Freedom Systems - D Alembert's Principle, Energy method, Rayleigh method, simple applications, equivalent spring stiffness. Damped Free Vibrations: Single Degrees of Freedom System -different types of damping, Viscous damping, sub-critical, critical and over damping, logarithmic decrement, and frequency of damped oscillations. Forced Vibrations: Single Degrees of Freedom System - Solution for simple harmonic excitation, steady state vibrations, Rotating and reciprocating unbalance, base excitation, vibration isolation and transmissibility, whirling of shaft without friction.	9
II	**TWO DEGREE OF FREEDOM SYSTEM** Introduction-Free vibration of undamped and damped systems - Forced vibration with Harmonic excitation System –Coordinate couplings and Principal Coordinates.	9
III	**MULTI-DEGREE OF FREEDOM SYSTEMS** Lagrange's equation, Dunkerley's approximation method, Rayleigh method, matrix method, matrix iteration, orthogonality principle, modal analysis, Stodola method, Holzer method, Galerkin method, Rayleigh - Ritz method.	9
IV	**CONTINUOUS SYSTEMS AND VIBRATION CONTROL** Continuous Systems -Longitudinal vibrations of bar, transverse vibration of beam, torsion of vibrations of circular shaft with various end conditions. Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic vibration absorber, Torsional and Pendulum Type absorber-Damped Vibration absorbers-Static and Dynamic balancing-Balancing machines-Field balancing - Active Vibration Control.	9
V	**EXPERIMENTAL METHODS IN VIBRATION ANALYSIS** Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings-Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments- System Identification from Frequency Response -Testing for resonance and mode shapes.	9
	Total Instructional Hours	**45**

Course Outcome

Student shall be able to

CO1: Detect the problem of machine tool vibration.
CO2: Analyze the problem to get rid of any machine vibration trouble.
CO3: Attain the vibration control methods.
CO4: Develop skills on experimental methods.
CO5: Execute the principles in real time vibration problems.

TEXT BOOKS:

T1- Singh V.P, "Mechanical Vibrations", Dhanpat Rai and Company Pvt. Ltd., 3rd ed., 2006.
T2- Rao S.S , "Mechanical Vibrations", Pearson Education, 2004

REFERENCE BOOKS:

R1- Thomson W.T, "Theory of Vibration with Applications", Prentice Hall of India, 1997.
R2- Ashok Kumar Mallik, "Principles of Vibration Control", Affiliated East-West Press Pvt. Ltd, 1990.
R3- Lewis H Bell, "Industrial Noise Control Fundamentals and Applications", Marcel Dekkev Inc. 1982.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3307	OPTIMIZATION TECHNIQUES IN DESIGN	3	1	0	3

Course Objective

1. To understand the basic concepts of unconstrained optimization techniques.
2. To understand the basic concepts of constrained optimization techniques.
3. To implement optimization approaches and to select appropriate solution for design application.
4. To demonstrate selected optimization algorithms commonly used in static and dynamic applications

Unit	Description	Instructional Hours
I	**UNCONSTRAINED OPTIMIZATION TECHNIQUES** Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.	10
II	**CONSTRAINED OPTIMIZATION TECHNIQUES** Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming	10
III	**ADVANCED OPTIMIZATION TECHNIQUES** Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.	10
IV	**STATIC APPLICATIONS** Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.	8
V	**DYNAMIC APPLICATIONS** Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.	7
	Total Instructional Hours	**45**

Course Outcome

CO1 Formulate unconstrained optimization techniques in engineering design application.
CO2. Formulate constrained optimization techniques for various application.
CO3. Apply genetic algorithms to combinatorial optimization problems.
CO4. Evaluate solutions by various static application design problem.

TEXT BOOKS:

T1 - Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, 1989.
T2 - Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, 1990.

REFERENCE BOOKS:

R1 - Kalyanamoy Deb, “Optimization for Engineering design algorithms and Examples”, Prentice Hall of India Pvt. 1995.
R2 - Rao, Singaresu, S., “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2000.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3308	TRIBOLOGY IN DESIGN	3	1	0	3

Course Objective

1. To impart knowledge in friction, wear and lubrication aspects of machine components.
2. To understand the material properties this influences the tribological characteristics of surfaces.
3. To understand the analytical behavior and design of bearings based on analytical /theoretical approach.
4. To learn the surface treatment methods.
5. To enable the students in learning with pressure contacts and elasto hydrodynamic lubrication**.**

Unit	Description	Instructional Hours
I	**SURFACE INTERACTION AND FRICTION** Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact.	7
II	**WEAR AND SURFACE TREATMENT** Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non metals – Surface treatments – Surface modifications –surface coatings methods- Surface Topography measurements –Laser methods – instrumentation – International standards in friction and wear measurements.	8
III	**LUBRICANTS AND LUBRICATION REGIMES** Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication Hydrodynamic lubrication — Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.	8
IV	**HYDRODYNAMIC AND HYDROSTATIC LUBRICATION** Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings.	12
V	**PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION** Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication theory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives.	10
	Total Instructional Hours	**45**

Course Outcome

Students shall be able to

CO1: Apply in long life product development areas.

CO2: Strengthen the skills in failure analysis and condition monitoring.

CO3: Acquire the knowledge of various lubrication techniques.

CO4: Calculate the friction, load and flow occurrence level over components.

CO5: Execute the Laser methods in the engineering field.

TEXT BOOKS:

T1- Rabinowicz.E, “Friction and Wear of materials”, John Willey & Sons, UK, 1995

T2- Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.

REFERENCE BOOKS:

R1- Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.

R2- S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, PHI Pvt Ltd , New Delhi, 2005

R3- Stachowiak G.W. & A.W .Batchelor, Engineering Tribology, Butterworth-Heinemann, UK, 2005.

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SEMSTER III - ELECTIVE V

Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3309	ADVANCED TOOL DESIGN	3	0	0	3

Course Objective

1. To understand the concepts of design procedures for machining.
2. To learn the concepts of cutting tools.
3. To know the information of jigs and fixtures.
4. To impart the knowledge of design of press tool dies.
5. To familiarize the concepts of tool design.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO TOOL DESIGN** Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings –Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials-Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment.	8
II	**DESIGN OF CUTTING TOOLS** Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.	9
III	**DESIGN OF JIGS AND FIXTURES** Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures –Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.	10
IV	**DESIGN OF PRESS TOOL DIES** Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout –Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting.	10
V	**TOOL DESIGN FOR CNC MACHINE TOOLS** Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool petitioners – Tool presetting– General explanation of the Brown and Sharp machine.	8
	Total Instructional Hours	**45**

Course Outcome

Student shall be able to

CO1: Develop knowledge about cutting tools.

CO2: Design Jigs & fixtures.

CO3: Dies & Press tools for conventional & CNC machines.

CO4: know about the tool holding methods, Automatic tool changers and tool petitioners.

CO5: Execute the principles in real time problems.

TEXT BOOKS:

T1- Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.

T2- Hoffman E.G.," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004

REFERENCE BOOKS:

R1- Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20CC3312	BASICS AND APPLICATIONS FOR INTERNET OF THINGS	3	0	0	3

Course Objective

1. To expose the students to the evolution of IOT to the various applications.
2. To impart knowledge about IOT and its techniques.
3. Elucidate emerging needs in IOT technology and incorporate into basic education that can be immediately employed in industry.
4. Promote interdisciplinary interactions among engineering, engineering technology, science, and industrial management/technology majors.
5. Assess the effectiveness of the newly developed concepts of IOT technology.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Machine to Machine (M2M) to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.	9
II	**IoT STRUCTURE** **M2M to IoT – A Market Perspective**– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. **M2M to IoT-An Architectural Overview**– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.	9
III	**IoT NETWORKING** **M2M and IoT Technology Fundamentals-** Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.	9
IV	**IoT ARCHITECTURE** **IoT Architecture-State of the Art –** Introduction, State of the art, **Architecture Reference Model-** Introduction, Reference Model and architecture, IoT reference Model.	9
V	**ARCHITECTURE MODELING** **IoT Reference Architecture-** Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. **Real-World Design Constraints-** Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. **Industrial Automation-** Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, **Commercial Building Automation-** Introduction, Case study: phase one-commercial building automation today, Case study: phase two-commercial building automation in the future.	9
	Total Instructional Hours	**45**

Course Outcome

At the end of the course the student will be able to:

CO1 Understand the vision of IoT from a global context.

CO2 Determine the Market perspective of IoT.

CO3 Use of Devices, Gateways and Data Management in IoT.

CO4 Build state of the art architecture in IoT.

CO5 Apply of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

TEXT BOOKS:

T1- Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013.

T2- Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

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OPEN ELECTIVE

Programme	Course Code	Name of the Course	L	T	P	C
ME CAD/CAM	20CC3401	MICRO ELECTRO MECHANICAL SYSTEMS	3	0	0	3

Course Objective

1. Understand various concepts of Micro Electro Mechanical Systems.
2. Study important methods of fabrication process and its materials.
3. Gain knowledge about the concepts of micromechanics.
4. To learn about micro system manufacturing.
5. Study the design considerations of micro system.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Overview-Microsystems and microelectronics - Working principle of Microsystems -micro actuation techniques-micro sensors-types-micro actuators-types-micro pump-micro motors and micro valves-micro grippers-scaling laws-scaling in geometry-scaling in rigid body dynamics-scaling in electrostatic forces- scaling in electricity- scaling in fluid mechanics and scaling in heat transfer.	9
II	**MATERIALS AND FABRICATION PROCESS** Substrates and wafer-single crystal silicon wafer formation-ideal substrates-mechanical properties-silicon compounds - Sio2, SiC, Si3N4 and polycrystalline silicon – Silicon piezo resistors - Gallium arsenide, Quartz-piezoelectric crystals-polymers for MEMS - conductive polymers – Photolithography - Ion implantation - Diffusion – Oxidation –CVD - Physical vapor deposition - Deposition by epitaxy - etching process.	9
III	**MICROMECHANICS** Introduction-static bending of thin plates-circular plates with edge fixed - rectangular plate with all edges fixed and square plate with all edges fixed – Mechanical vibration-resonant vibration- micro accelerometers-design theory and damping coefficients- thermo mechanics thermal Stresses-fracture mechanics-stress intensity factors, fracture toughness and interfacial fracture mechanics.	9
IV	**MICRO SYSTEM MANUFACTURING** Clean room technology-Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA Micro System packaging-materials-die level-device level-system level-packaging techniques-die preparation-surface bonding-wire bonding-sealing.	9
V	**MICRO SYSTEM DESIGN** Design considerations-process design-mask layout design- mechanical design-applications of micro system in -automotive industry-bio medical –aero space-telecommunications.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the principles of Microsystems.
CO2: Identify the fabrication process and its materials.
CO3: Gain knowledge about structural and thermal micromechanics.
CO4: To analyze the micro system manufacturing.
CO5: Able to explain the design principles of Micro system techniques

TEXT BOOKS:

T1 - Mohamed Gad-el-Hak, The MEMS Hand book, CRC press 2002.
T2 - Julian W.Gardner,Vijay K.Varadan,Osama O.Awadel Karim,Microsensors MEMS and Smart Devices, John Wiby & sons Ltd.,2001.

REFERENCE BOOKS:

R1 – Fatikow .S, Rembold .U, Microsystem Technology and Microrobotics, Springer-Verlag Berlin Heidelberg, 1997.

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AUDIT COURSES (AC) - SEMESTER I

Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC1091	ENGLISH FOR RESEARCH PAPER WRITING	2	0	0	0

Course Objective

1. Teach how to improve writing skills and level of readability
2. Tell about what to write in each section
3. Summarize the skills needed when writing a Title
4. Infer the skills needed when writing the Conclusion
5. Ensure the quality of paper at very first-time submission

Unit	Description	Instructional Hours
I	**INTRODUCTION TO RESEARCH PAPER WRITING** Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	6
II	**PRESENTATION SKILLS** Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction	6
III	**TITLE WRITING SKILLS** Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	6
IV	**RESULT WRITING SKILLS** Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	6
V	**VERIFICATION SKILLS** Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission	6
	Total Instructional Hours	**30**

Course Outcome

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

TEXT BOOKS:

T1- Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
T2- Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006

REFERENCE BOOKS:

R1- Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
R2- Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC1092	Disaster Management	2	0	0	0

Course Objective

1. Summarize basics of disaster
2. Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3. Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4. Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5. Develop the strengths and weaknesses of disaster management approaches.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude	6
II	**REPERCUSSIONS OF DISASTERS AND HAZARDS** Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	6
III	**DISASTER PRONE AREAS IN INDIA** Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics	6
IV	**DISASTER PREPAREDNESS AND MANAGEMENT** Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.	6
V	**RISK ASSESSMENT** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival	6
	Total Instructional Hours	**30**

Course Outcome

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

TEXT BOOKS:

T1- Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.

T2- NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC1093	SANSKRIT FOR TECHNICAL KNOWLEDGE	2	0	0	0

Course Objective

1. Illustrate the basic sanskrit language.
2. Recognize sanskrit, the scientific language in the world.
3. Appraise learning of sanskrit to improve brain functioning.
4. Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
5. Extract huge knowledge from ancient literature.

Unit	Description	Instructional Hours
I	**ALPHABETS** Alphabets in Sanskrit.	6
II	**TENSES AND SENTENCES** Past/Present/Future Tense - Simple Sentences	6
III	**ORDER AND ROOTS** Order - Introduction of roots	6
IV	**SANSKRIT LITERATURE** Technical information about Sanskrit Literature	6
V	**TECHNICAL CONCEPTS OF ENGINEERING** Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	6
	Total Instructional Hours	**30**

Course Outcome

CO1 - Understanding basic Sanskrit language.
CO2 - Write sentences.
CO3 - Know the order and roots of Sanskrit.
CO4 - Know about technical information about Sanskrit literature.
CO5 - Understand the technical concepts of Engineering.

TEXT BOOKS:

T1- "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
T2- "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

REFERENCE BOOKS:

R1- 3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC1094	CONSTITUTION OF INDIA	2	0	0	0

Course Objective

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
3. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
4. To address the role of socialism in India after the commencement of the Bolshevik
5. Revolutionin1917and its impact on the initial drafting of the Indian Constitution..

Unit	Description	Instructional Hours
I	**HISTORY OF MAKING OF THE INDIAN CONSTITUTION** History, Drafting Committee, (Composition & Working)	3
II	**PHILOSOPHY OF THE INDIAN CONSTITUTION:** Preamble, Salient Features	3
III	**CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties..	6
IV	**ORGANS OF GOVERNANCE** Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.	6
V	**LOCAL ADMINISTRATION** District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy	6
VI	**ELECTION COMMISSION** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.	6
	Total Instructional Hours	**30**

Course Outcome

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2: Discuss the intellectual origins of the framework of argument that informed the Conceptualization
CO3: Approach of social reforms leading to revolution in India.
CO4: Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO5:Discuss the passage of the Hindu Code Bill of 1956.

TEXT BOOKS:

T1- The Constitution of India, 1950 (Bare Act),Government Publication.
T2- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.

REFERENCE BOOKS:

R1- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
R2- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC1095	PEDAGOGY STUDIES	2	0	0	0

Course Objective

1. Review existing evidence on there view topic to inform programme design and policy
2. Making under taken by the DfID, other agencies and researchers.
3. Identify critical evidence gaps to guide the development.

Unit	Description	Instructional Hours
I	**INTRODUCTION AND METHODOLOGY** Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.	6
II	**THEMATIC OVERVIEW** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.	6
III	**EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.	6
IV	**PROFESSIONAL DEVELOPMENT** Professional development: alignment with classroom practices and follow up support – Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.	6
V	**RESEARCH GAPS AND FUTURE DIRECTIONS** Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.	6
	Total Instructional Hours	**30**

Course Outcome

CO1: What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
CO2: What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
CO3: How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING:

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.

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AUDIT COURSES (AC)
SEMESTER II

Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC2091	VALUE EDUCATION	2	0	0	0

Course Objective

1. Understand value of education and self-development
2. Imbibe good values in students
3. Let the should know about the importance of character

Unit	Description	Instructional Hours
I	Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements	7
II	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline	7
III	Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature	9
IV	Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively..	7
	Total Instructional Hours	**30**

Course Outcome

Student shall able to
CO1: Knowledge of self-development.
CO2: Learn the importance of Human values.
CO3: Developing the overall personality

SUGGESTED READING:

T1- Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC2092	STRESS MANAGEMENT BY YOGA	2	0	0	0

Course Objective
1. To achieve overall health of body and mind
2. To overcome stress.

Unit	Description	Instructional Hours
I	Definitions of Eight parts of yoga.(Ashtanga)	10
II	Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.	10
III	Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam	10
	Total Instructional Hours	**30**

Course Outcome
Student shall be able to
CO1: Develop healthy mind in a healthy body thus improving social health also
CO2: Improve efficiency.

SUGGESTED READING:

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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Programme	Course Code	Name of the Course	L	T	P	C
M.E CAD/CAM	20AC2093	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	2	0	0	0

Course Objective	1. To learn to achieve the highest goal happily 2. To become a person with stable mind, pleasing personality and determination 3. To awaken wisdom in students

Unit	Description	Instructional Hours
I	Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)	10
II	Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.	10
III	Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63.	10
	Total Instructional Hours	**30**

Course Outcome	Student shall be able to CO1: Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life CO2: The person who has studied Geeta will lead the nation and mankind to peace and prosperity CO3: Study of Neet is hatakam will help in developing versatile personality of students..

SUGGESTED READING:

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringarvairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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CO'S, PO'S & PSO'S MAPPING

Semester – I

Course Code & Name : 20MA1104 Applied Mathematics for Engineers

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	3	2	1	1	-	-	-	-	-	1	2	2	2
CO2	2	3	2	1	1	-	-	-	-	-	1	2	2	2
CO3	2	2	2	2	1	-	-	-	-	-	1	2	2	2
CO4	2	2	3	1	2	-	-	-	-	-	2	2	3	3
CO5	2	3	3	2	2	-	-	-	-	-	3	2	3	3
Avg	2	2.6	2.4	1.4	1.4	-	-	-	-	-	1.6	2	2.4	2.4

Course Code & Name : 20CC1201 Computer Aided Design

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	2		2							1	1
CO2	2	3	2	2		2		1		1			1	2
CO3	3	2	3	2		1		1					1	1
CO4	1	2	2	1		1							2	2
CO5	2	2	3	1		1							1	2
Avg	3	3	3	2		2							1	1

Course Code & Name : 20CC1202 Integrated Mechanical Design

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	3	-	-	-	-	-	-	-	-	-	-	1
CO2	3	2	3	-	-	-	-	-	-	-	-	-	-	1
CO3	3	3	3	-	-	-	-	-	-	-	-	-	-	1
CO4	3	3	3	-	-	-	-	-	-	-	-	-	-	1
CO5	3	3	3	-	-	-	-	-	-	-	-	-	-	2
Avg	3	2.6	3	0	0	0	0	0	0	0	0	0	0	1.2

Course Code & Name : 20CC1203 Computer Aided Manufacturing

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	2	-	3	-	-	-	-	3	2	3	3	1
CO2	3	2	2	2	3	-	-	-	-	3	3	3	3	1
CO3	3	1	2	2	3	-	-	-	-	3	3	3	3	2
CO4	3	1	2	-	3	-	-	-	-	2	2	3	2	1
CO5	3	1	2	-	3	-	-	-	-	3	3	3	3	2
Avg	3	1.2	2	2	3	0	0	0	0	2.8	2.6	3	2.8	1.4

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Course Code & Name : 20RM1153 Research Methodology and IPR

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	1	2	2	1	1	1	1	1	1	1	1	2
CO2	3	3	2	2	1	1	1	1	1	1	1	1	1	2
CO3	3	3	1	2	1	1	1	1	2	1	1	2	1	1
CO4	3	3	2	1	2	2	1	1	2	1	1	1	1	1
CO5	3	3	2	1	1	1	1	1	1	1	1	1	1	1
Avg	3	3	1.6	1.6	1.4	1.2	1	1	1.4	1	1	1.2	1	1.4

Course Code & Name : 20CC1001 Computer Aided Design Lab

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	2	1	1	-	-	-	-	3	3	3	3	2
CO2	1	2	2	1	2	-	-	-	-	2	2	3	2	2
CO3	1	2	2	1	2	-	-	-	-	2	2	3	2	1
Avg	1.3	2	2	1	1.6	0	0	0	0	2.3	2.3	3	1.3	1.6

Course Code & Name : 20CC1002 Computer Aided Manufacturing Lab

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	-	-	-	3	-	-	-	-	2	-	2	3	1
CO2	2	-	-	-	3	-	-	-	-	2	-	2	3	1
CO3	2	-	-	-	3	-	-	-	-	2	-	2	3	1
Avg	2				3					2		2	3	1

Semester – II

Course Code & Name : 20CC2201 Finite Element Analysis

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3		1		2	1	1	1	2			3	2	2
CO2	3	1	2		2	1	1	1	1			1	2	2
CO3	2	1	2	1	3	2	2	1	1			1	2	2
CO4	3	1	1	1	2	1	1	1	1			1	3	3
CO5	2	1	1	1	3	2	2	1	2			3	2	2
Avg	2.6	1	1.4	1	2.4	1.4	1.4	1	1.4	0	0	1.8	2.2	2.2

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Course Code & Name : 20CC2202 Integrated Product and Processes Development

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	1	1	1	-	-	-	-	1	-	1	-	1
CO2	3	1	1	2	1	-	-	-	-	1	-	1	-	1
CO3	3	2	2	2	1	-	-	-	-	1	-	1	-	1
CO4	3	1	1	1	2	-	-	-	-	2	-	1	3	1
CO5	3	1	2	1	2	-	-	-	-	2	-	1	3	1
Avg	3	1.2	1.4	1.4	1.4	0	0	0	0	1.4	0	1	3	1

Course Code & Name : 20CC2203 Design for Manufacture Assembly and Environment

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	3	3	3	1	-	-	3	3	3	1	3	1
CO2	3	3	3	3	3	2	1	-	3	3	3	1	3	1
CO3	3	3	3	3	3	1	1	-	3	2	2	1	3	2
CO4	3	3	3	3	3	-	2	1	2	1	2	1	3	1
CO5	3	3	3	3	2	3	3	3	2	1	1	1	3	3
Avg	3	2.6	3	3	2.8	1.2	1.4	0.8	2.6	2	2.2	1	3	1.6

Course Code & Name : 20CC2305- Metrology And Non Destructive Testing

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	1	1	1	-	-	-	-	1	-	1	-	1
CO2	3	1	1	2	1	-	-	-	-	1	-	1	-	1
CO3	3	2	2	2	1	-	-	-	-	1	-	1	-	1
CO4	3	1	1	1	2	-	-	-	-	2	-	1	3	1
CO5	3	1	2	1	2	-	-	-	-	2	-	1	3	1
Avg	3	1.2	1.4	1.4	1.4	-	-	-	-	1.4	-	1	1.2	1

Course Code & Name : 20CC2307 - Advances In Welding And Casting

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	1	1	2	1	-	-	-	-	1	1	2	1
CO2	2	1	-	1	1	1	-	-	-	-	-	1	2	1
CO3	1	1	2	1	1	-	-	-	-	-	-	-	1	1
CO4	1	1	1	-	1	-	-	-	-	-	1	1	2	2
CO5	2	1	-	2	1	-	-	-	-	-	1	1	2	2
Avg	1.8	1	1.3333	1.25	1.2	1	0	0	0	0	1	1	1.8	1.4

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Course Code & Name : 20CC2001 Computer Aided Engineering Lab

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	-	-	-	3	-	-	-	-	2	-	2	3	1
CO2	2	-	-	-	3	-	-	-	-	2	-	2	3	1
CO3	2	-	-	-	3	-	-	-	-	2	-	2	3	1
Avg	2				3					2		2	3	1

Course Code & Name: 20CC2002 Inplant Training /Internship/Miniproject

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1		2			2		3	3	3	2		2		
CO2		2			2		3	3	3	2		2		
CO3		2			2		3	3	3	2		2		
CO4		2			2		3	3	3	2		2		
CO5		2			2		3	3	3	2		2		
Avg		2			2		3	3	3	2		2		

Semester – III

Course Code & Name : 20CC3301 Enterprise Resource Planning

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	-	-	-	1	1	-	-	-	-	3	2	1	1
CO2	-	-	-	-	3	-	-	-	-	-	2	2	1	1
CO3	-	-	-	2	3	-	-	-	-	2	2	2	2	1
CO4	2	-	1	-	2	-	-	-	1	-	2	2	2	2
CO5	-	-	2	-	-	3	2	-	-	-	-	-	2	2
Avg	2	0	1.5	2	2.25	2	2	0	1	2	2.25	2	1.6	1.4

Course Code & Name : 20CC3312 & Basics and Applications of Internet Of Things

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	3	3	3	1	-	-	3	3	3	1	3	1
CO2	3	3	3	3	3	2	1	-	3	3	3	1	3	1
CO3	3	3	3	3	3	1	1	-	3	2	2	1	3	2
CO4	3	3	3	3	3	-	2	1	2	1	2	1	3	1
CO5	3	3	3	3	2	3	3	3	2	1	1	1	3	3
Avg	3	2.6	3	3	2.8	1.4	1.4	0.8	2.6	2.0	2.2	1	3	1.6

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Course Code & Name : 20CC3304 Industrial Robotics And Expert Systems

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	1	-	2	1	2	-	-	1	2	3	2	2
CO2	3	1	1	-	2	1	2	-	-	1	2	3	2	2
CO3	3	1	2	-	2	1	2	1	1	1	2	3	2	2
CO4	3	1	2	1	2	1	2	1	1	1	2	3	2	2
CO5	3	1	2	1	2	1	2	1	1	1	2	3	2	2
Avg	3	1	1.6	1	2	1	2	1	1	1	2	3	2	2

Course Code & Name : 20CC3901 Dissertation- I

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	2	3		2	2			3		1	2	1	1
CO2	2	2	2		2	2			3		1	2	1	1
CO3	2		3	1	1	2			3		1	1	1	1
CO4	1	3	3		2	2			3		1	1		1
CO5	2	2	3	1	1	1			3			2	1	
Avg	1.4	2.25	2.8	1	1.6	1.8			3		1	1.6	1	1

Semester – IV

Course Code & Name : 20CC4901 Dissertation- II

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	2	3		2	2			3		1	2	1	1
CO2	2	2	2		2	2			3		1	2	1	1
CO3	2		3	1	1	2			3		1	1	1	1
CO4	1	3	3		2	2			3		1	1		1
CO5	2	2	3	1	1	1			3			2	1	
Avg	1.4	2.25	2.8	1	1.6	1.8			3		1	1.6	1	1

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Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 11	PSO 12
I	I	**20MA1104 Applied Mathematics for Engineers**	2	2.6	2.4	1.4	1.4	-	-	-	-	-	1.6	2	2.4	2.4
		20CC1201 Computer Aided Design	3	3	3	2		2							1	1
		20CC1202 Integrated Mechanical Design	3	2.6	3	0	0	0	0	0	0	0	0	0	0	1.2
		20CC1203 Computer Aided Manufacturing	3	1.2	2	2	3	0	0	0	0	2.8	2.6	3	2.8	1.4
		20RM1153 Research Methodology and IPR	3	3	1.6	1.6	1.4	1.2	1	1	1.4	1	1	1.2	1	1.4
		20CC1001 Computer Aided Design Lab	1.3	2	2	1	1.6	0	0	0	0	2.3	2.3	3	1.3	1.6
		20CC1002 Computer Aided Manufacturing Lab	2				3					2		2	3	1
	II	**20CC2201 Finite Element Analysis**	2.6	1	1.4	1	2.4	1.4	1.4	1	1.4	0	0	1.8	2.2	2.2
		20CC2202 Integrated Product and Processes Development	3	1.2	1.4	1.4	1.4	0	0	0	0	1.4	0	1	3	1
		20CC2203 Design for Manufacture Assembly and Environment	3	2.6	3	3	2.8	1.2	1.4	0.8	2.6	2	2.2	1	3	1.6
		20CC2305- Metrology And Non Destructive Testing	3	1.2	1.4	1.4	1.4	-	-	-	-	1.4	-	1	1.2	1
		20CC2307 - Advances In Welding And Casting	1.8	1	1.3	1.25	1.2	1	0	0	0	0	1	1	1.8	1.4
		20CC2001 Computer Aided Engineering Lab	2				3					2		2	3	1
		20CC2002 Inplant Training /Internship/Miniproject		2			2		3	3	3	2		2		
II	III	**20CC3301 Enterprise Resource Planning**	2	0	1.5	2	2.25	2	2	0	1	2	2.2	2	1.6	1.4
		20CC3312 & Basics and Applications of Internet Of Things	3	2.6	3	3	2.8	1.4	1.4	0.8	2.6	2	2.2	1	3	1.6
		20CC3304 Industrial Robotics And Expert Systems	3	1	1.6	1	2	1	2	1	1	1	2	3	2	2
		20CC3901 Dissertation- I	1.4	2.25	2.8	1	1.6	1.8			3		1	1.6	1	1
	IV	**20CC4901 Dissertation- II**	1.4	2.25	2.8	1	1.6	1.8			3		1	1.6	1	1

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