

**M.Tech COMPUTER INTEGRATED MANUFACTURING (CIM)
Curriculum & Syllabus
2015 – 2016**

**FACULTY OF ENGINEERING AND TECHNOLOGY
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203**

M.Tech. COMPUTER INTEGRATED MANUFACTURING (CIM)
Curriculum 2015 – 2016
For students admitted from the academic year 2015 – 2016

Type of course	Credits to be earned
Core courses	24
Optional / Elective Courses (Program Electives)	15
Interdisciplinary elective	3
Supportive courses	6
Other Courses	1
Project work Phase I &II	22 (6+16)
Career Advancement Course For Engineers	3
Total	74
Total credits to be earned for the award of M.Tech. degree – 74	

Core courses					
COURSE CODE	COURSE NAME	L	T	P	C
ME2201 / ME2202	Computer Aided Design in Manufacturing (or) Finite Element Analysis in Manufacturing	3	0	2	4
ME2203 / ME2204	Principles of Computer Integrated Manufacturing Systems(or) CNC Machining Technology	3	0	2	4
ME2205 / ME2206	Manufacturing Information Systems (or) Manufacturing Systems Simulation	3	2	0	4
ME2207	Sensors for Intelligent Manufacturing and Condition Monitoring	3	0	2	4
ME2208	Computer Aided Inspection and Non Destructive Evaluation	3	0	2	4
ME2209	Advanced Materials Engineering	3	0	2	4

Optional / Elective Courses (Program Electives)					
COURSE CODE	COURSE NAME	L	T	P	C
ME2119	Concurrent Engineering	3	0	0	3
ME2122	Rapid Prototyping and Tooling	3	0	0	3
ME2211	Applications of Computers in Manufacturing	3	0	0	3
ME2212	Artificial Intelligence and Expert Systems in Manufacturing	3	0	0	3
ME2213	Automated Material Handling systems	3	0	0	3
ME2214	Computer Aided Process Planning	3	0	0	3
ME2215	Design for Manufacture and Assembly	3	0	0	3
ME2216	Design of Experiments	3	0	0	3
ME2217	Flexible Manufacturing Systems	3	0	0	3
ME2218	Group Technology and Cellular Manufacturing systems	3	0	0	3
ME2219	Machine Vision and its Applications	3	0	0	3
ME2220	Manufacturing Planning & Control	3	0	0	3
ME2221	Production and Operation Management	3	0	0	3
ME2222	Robotics and Robot Applications	3	0	0	3
ME2223	Supply Chain Management	3	0	0	3
ME2224	Sustainable Green Manufacturing	3	0	0	3
ME2225	Total Quality Systems and Engineering	3	0	0	3

Supportive courses					
COURSE CODE	COURSE NAME	L	T	P	C
MA2006 / MA2007	Computational Methods in Engineering (or) Applied Mathematics for Mechanical Engineers	3	0	0	3
ME2291 / ME2292	Global Optimization Algorithms (or) Mechatronics in Manufacturing Systems	3	0	0	3

Other Courses					
		L	T	P	C
ME2296	Seminar	0	0	1	1
CAC2001	Career Advancement Course For Engineers – I	1	0	1	1
CAC2002	Career Advancement Course For Engineers – II	1	0	1	1
CAC2003	Career Advancement Course For Engineers - III	1	0	1	1

	Project Work	L	T	P	C
ME2297	Project work Phase I	0	0	12	6
ME2298	Project work Phase II	3	0	32	16

Guidelines for choosing courses

Category	No. of Courses			
	I Semester	II Semester	III Semester	IV Semester
Core courses	3	3	-	-
Optional / Elective Courses	1	1	3	-
Supportive courses	1	1	-	-
Interdisciplinary elective	1 course of 3 credits to be taken in I-III semesters			
Seminar	-	-	1	-
Career Advancement Courses	1	1	1	-
Project work Phase I	-	-	1	-
Project work Phase II	-	-	-	1
Total number of credits to be earned for the award of degree -74				

CONTACT HOUR/CREDIT:

L - Lecture Hours per week

P - Practical Hours per week

T - Tutorial Hours per week

C - Credit

ME2201	COMPUTER AIDED DESIGN IN MANUFACTURING	L	T	P	C
	Total contact hours – 75	3	0	2	4
	Prerequisites				
	Nil				
PURPOSE					
To give clear idea about the role of computer aided design in manufacturing to students.					
INSTRUCTIONAL OBJECTIVES					
To introduce					
1.	The role of computers in design and manufacture.				
2.	Both the hardware and software of CAD/CAM systems together with the practical discussion of their use in engineering.				
3.	Computer graphics for drafting and analysis.				
4.	Integration of CAD, Simulation, Manufacturing, Production planning and control.				

UNIT I - HIERARCHY OF COMPUTERS IN MANUFACTURING (10 hours)

Introduction-Role of computers in design and manufacture. Design considerations in hierarchical network of computers-Levels of hierarchy – Local area networks - Network topologies – Manufacturing automation protocol. The planning function – Types of CAPP – retrieval and generative type CAPP – Programming & NC Machines - NC part programming – Punched tape and tape format – Manual and computer assisted part programming – Manual data input – NC programming using CAD/CAM – Computer automated part programming

UNIT II - CAD/CAM HARDWARE/SOFTWARE (9 hours)

Types of computer Systems, Devices and their functioning (work stations, PC's, mouse, Floppy drive, digitizer, display devices, key board. etc.) - CAD/CAM Software- Operating System-Graphics Standards –Basic Definitions, modes of graphics operations-User interface-Software Modules- Software Development.

UNIT III - TWO DIMENSIONAL AND THREE DIMENSIONAL TRANSFORMATIONS (9 hours)

2D-representation and Transformation of points- Transformation lines – Rotation, Scaling, Translation, reflection and combined transformations – 3D Scaling – Rotation – Translation – Reflection. Windowing, View ports, Clipping.

UNIT IV - MODELLING AND ANALYSIS**(9 hours)**

3D-Modelling – Wire Frame, Surface and Solid Modeling – Solid Modeling Packages
 Finite element method – Fundamental of Finite element modeling – 2D & 3D
 Elements, Analysis of results.– Finite Element Analysis(FEA) – Introduction and
 Procedure – Introduction to FEA Packages.

UNIT V - COMPUTER INTEGRATED DESIGN**(8 hours)**

Design Phases – Standardization and Interchangeability of Machine Elements,
 Concurrent Engineering – meaning, scheme and design of concurrent engineering,
 design for assembly and modular construction – Concept of integration. Data base for
 CAD.

REFERENCES

1. Mustapha. I., "*Concurrent Engineering*", New Age International Pvt. Ltd., 2002.
2. Ibrahim Zeid, "*CAD/CAM, theory and practice*", Tata McGraw Hill edition, 1998.
3. Groover M.P., "*Automation, production systems and computer integrated manufacturing*", Prentice- Hall of India Pvt. Ltd., 1996.
4. David F Rogers and Alan Adams, "*Mathematical elements for computer graphics*", McGraw Hill publishing Co. Int. Edition, 1990.
5. William.M. Newman Robert. F. Sproull, 'Principles of interactive graphics', McGraw Hill publishing Co. Int. Edition, 1984.
6. www.CAD/CAM- magazine .CO .UK.

ME2202	FINITE ELEMENT ANALYSIS IN MANUFACTURING				
	L	T	P	C	
	Total contact hours – 75	3	0	2	4
	Prerequisites				
Nil					
PURPOSE					
To present the basics of finite element analysis and its applications in Manufacturing to the students in a structured way.					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	Basic concepts and different methods used in finite element analysis.				
2.	Analysis of one dimensional and two dimensional problems using finite element methods.				
3.	Applications of FEA in manufacturing.				
4.	Computer implementation of FEM and application packages like ANSYS, DEFORM, etc.,				

UNIT I - INTRODUCTION TO FINITE ELEMENT ANALYSIS(15 hours)

Basics of FEA, historical background, FEM applications, review of matrix algebras, equations solving- Gauss elimination ,Choleski method. General field problems in

engineering, Modeling – discrete and continuous models, calculus of variations- Boundary and initial value problems, variational formulation in finite elements, , Rayleigh ,Ritz method, weighted residual methods – Galerkin method ,sub domain method, method of least square and collocation method, numerical problems.

UNIT II - FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS

(15 hours)

General procedure of FEM, skeletal and continuum structures, discretization of domain, basic types of elements, shape functions, formulation of element stiffness matrices, truss, beam elements,. One dimensional second order equations ,shape functions for one dimensional and two dimensional elements -generalized coordinate approach, derivation of element equation- assembly of element equation- imposition of boundary conditions- solution of equation- Cholesky method- extension of the method to fourth order equation- time dependent problems from heat transfer and solid mechanics-heat transfer through simple fins, composite wall, bending of beams.

UNIT III - FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS

(15 hours)

Global and natural coordinates, triangular, quadrilateral and brick elements- isoparametric elements, Jacobian matrices and Transformations, Second order equations involving scalar valued function- model equation-variational formulation- finite element formulation through generalised coordinate approach – convergence criteria for chosen models-interpolation functions- element matrices-problems on bending of plates and heat transfer in two dimensions.

UNIT IV - APPLICATION OF FEA IN MANUFACTURING

(15 hours)

FE analysis of Metal casting – latent heat incorporation, time stepping procedure, analysis of metal forming- sheet metal stamping, Analysis of Metal cutting, chip separation criteria, incorporation of strain rate dependency.

UNIT V - COMPUTER IMPLEMENTATION OF FEM

(15 hours)

Preprocessing , mesh generation, element connecting, boundary conditions, input of material and processing characteristics, solution and post processing, Fundamentals of application packages like ANSYS, DEFORM and LS DYNA.

REFERENCES

1. Chandrupatla & Belegundu, "*Finite Elements in Engineering*", Prentice Hall of India Pvt. Ltd., 1997.
2. Reddy .J.N, "*An Introduction to Finite Element Method*", McGraw Hill International Editions, 2011.

3. Kobayashi.S, Soo-Ik-Oh, Altan.T, "*Metal Forming and Finite Element Methods*", Oxford University press, 1989
4. Rao.S.S. "*Finite Element Methods in Engineering*", Pregamon Press, 1989.
5. Krishnamoorthy .C.S., "*Finite Element Analysis- Theory and Programming*", Tata- McGraw Hill publishing Co, 1987.
6. Zienkiewicz.O.C. "*The Finite Element Method in Engg. Science*", McGraw Hill, London, 1977.
7. www.DEFORM.com
8. www.ansys.com

ME2203	PRINCIPLES OF COMPUTER INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
	Total contact hours – 75	3	0	2	4
	Prerequisites				
	Nil				
PURPOSE					
To enable the students to understand the basic principles of CIM and its elements.					
INSTRUCTIONAL OBJECTIVES					
To familiarise					
1.	The basic components of CIM and its hardware and software				
2.	CAD/CAM and its integration with CIM				
3.	FMS and its applications				
4.	Principles of computer aided process planning, JIT and GT				
5.	Different monitoring systems used in CIM				
6.	Computer Aided Quality Control and FIS				

UNIT I - INTRODUCTION TO CIM

(15 hours)

Manufacturing - Types, Manufacturing Systems, CIM Definition, CIM wheel, CIM components, Evolution of CIM, needs of CIM, Benefits of CIM, basic components of NC system, NC motion control system, applications of NC ,advantages and disadvantages of NC, computer Numerical control, advantages of CNC, functions of CNC, Direct Numerical Control, components of a DNC system, functions of DNC, advantages of DNC.

UNIT II - CAD

(15 hours)

Development of computers, CIM Hardware & Software, Data-Manufacturing data, types, sources, Structure of data models, Data base and DBMS- requirement, RDBMS, SQL, Computer Aided Design - benefits, Graphic Standards, Interfaces, CAD software, Integration of CAD/CAM/CIM.

UNIT III - FLEXIBLE MANUFACTURING SYSTEMS

(15 hours)

FMS concept, Components of FMS, FMS Layouts, FMS planning and implementation, . Tool Management systems-Tool monitoring, Work holding devices-Modular fixturing, flexible fixturing,, flexibility, quantitative analysis of flexibility, application and benefits of FMS, automated material handling system –AGVs, Guidance methods, AS/RS.

UNIT IV - AUTOMATED PROCESS PLANNING (15 hours)

Group Technology ,Part families, Part classification and coding, Production flow analysis, Machine cell design, Applications and Benefits of Group Technology, Structure of a Process Planning, Process Planning function, CAPP - Methods of CAPP, CAD based Process Planning, Inventory management - Materials requirements planning - basics of JIT

UNIT V - MONITORING AND QUALITY CONTROL (15 hours)

Types of production monitoring system, process control & strategies, direct digital control - Supervisory computer control - computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection systems. Integration of CAQC with CIM.

REFERENCES

1. Kant Vajpayee. S., "*Principles of Computer Integrated Manufacturing*", Prentice Hall of India, 1999.
2. Radhakrishnan.P, Subramanyan. S, "*CAD/CAM/CIM*", New Age International publishers, 2000.
3. Scheer.A.W., "*CIM- Towards the factory of the future*" Springer - Verlag, 1994.
4. Daniel Hunt.V., "*Computer Integrated Manufacturing Hand Book*", Chapman & Hall, 1989.
5. Groover M.P, "*Computer Aided Design and Manufacturing*", Prentice Hall of India, 1987.
6. Yorem Koren, "*Computer Control of Manufacturing System*", McGraw Hill, 1986.
7. Ranky Paul. G., "*Computer Integrated Manufacturing*", Prentice Hall International, 1986

ME2204	CNC MACHINING TECHNOLOGY	L	T	P	C
	Total contact hours – 75	3	0	2	4
	Prerequisite				
	Nil				

PURPOSE

To provide knowledge on principle, constructional features, programming, tooling and work holding devices in CNC machine tools

INSTRUCTIONAL OBJECTIVE

Upon completion of this subject, student will be able to:

1.	Understand of CNC machine tools and machining centres
2.	Describe constructional features of CNC machine tools
3.	Explain drives and tooling systems used in CNC machine tools
4.	Understand feedback and adaptive control of CNC machines
5.	Write simple programs for CNC turning and machining centres

UNIT I - INTRODUCTION TO CNC MACHINE TOOLS (6 hours)

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre-features and applications, Automatic tool changers and Multiple pallet system, types of control systems, CNC controllers, characteristics, interpolators.

UNIT II - STRUCTURE OF CNC MACHINE TOOL (10 hours)

CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings. Swarf removal and safety considerations.

UNIT III - DRIVES AND TOOLING SYSTEMS (9 hours)

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives – stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Tooling requirements for turning and machining centres, Introduction to cutting tool materials – Carbides, Ceramics, CBN, PCD–inserts, classification- qualified, semi qualified and preset tooling, coolant fed tooling system, work holding devices for rotating and fixed work parts, modular fixtures.

UNIT IV - FEEDBACK SYSTEMS AND ADAPTIVE CONTROL (10 hours)

Feed back systems: Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosyn, laser interferometer.

Adaptive Control – Adaptive control with constraints (ACC), Adaptive control with optimization (ACO), Geometric adaptive control (GAC)-basic concepts, Examples for ACC, ACO and GAC, Variable gain AC systems-stability problem, estimator algorithm, variable gain algorithm, Adaptive control of grinding process- grinding model, optimization strategy, design of adaptive control for grinding, sensors for adaptive control of CNC machine tools.'

UNIT V - CNC PROGRAMMING (10 hours)

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre .generation of CNC codes from CAM packages. Basics of APT.

PRACTICAL - 30 Hours

REFERENCES

1. Radhakrishnan P "*Computer Numerical Control Machines*", New Central Book Agency, 2002.
2. Rao P.N., *CAD/CAM*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.
3. Pabla, B.S. & Adithan, M. "*CNC Machines*", New Age Publishers, New Delhi 2005.
4. "*Mechatronics*", HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
5. Warren.S.Seames, "*Computer Numerical Control: Concepts and Programming*", 4th edition, Delmar Thomson Learning Inc., 2002.
6. James Madison, "*CNC Machining Hand Book*", Industrial Press Inc., 1996.
7. Peter Smid, "*CNC Programming Hand book*", Industrial Press Inc., 2000
8. Yoram Koren, "*Computer control of manufacturing systems*", McGraw Hill Book Co, 2005.

ME2205	MANUFACTURING INFORMATION SYSTEMS	L	T	P	C
	Total contact hours – 75	3	2	0	4
	Prerequisite				
	Nil				
PURPOSE					
To highlight the concepts and elements of Manufacturing Information Systems					
INSTRUCTIONAL OBJECTIVE					
To familiarize					
1.	Study of MRP, MRP II with role of production organization				
2.	Concepts of database				
3.	Designing of database				
4.	Models in manufacturing				
5.	Computerised manufacturing information system with practical application				

UNIT I - INTRODUCTION (5 hours)

The Evolution of order policies from MRP to MRP II, Operations control, the role of production organization.

UNIT II - DATABASE CONCEPTS (15 hours)

Data modeling for a database, records and files, abstraction and data integration. Three level architecture for DBMS, Components of DBMS, Advantages and disadvantages of DBMS.

UNIT III - DESIGNING DATABASE (20 hours)

Relationship among entities, ER diagram, Data Models: Relational, Network, Hierarchical. Relational Model – Concepts, principles, keys, Relational operations- Functional Dependency, Normalization, Query languages.

UNIT IV - MANUFACTURING CONSIDERATION (20 hours)

The product and its structure, Inventory and process flow, Shop floor control, Data structure and procedure. Various models - The order scheduling module- Input/Output analysis module- Stock status database- Complete IOM database.

UNIT V --INFORMATION SYSTEM FOR MANUFACTURING (15 hours)

Computerised manufacturing information system- Case study.

REFERENCES

1. Date. C.J, "An Introduction to Database systems", Narosa Publishing House, 1997.
2. BipinC.Desai, "An Introduction to Database systems", West Publishing Company, 1996.
3. Kerr. R, "Knowledge Based Manufacturing Management", Addison-Wesley, 1991.
4. Luca G. Sartori, "Manufacturing Information Systems", Addison-Wesley Publishing Company, 1988.

ME2206	MANUFACTURING SYSTEMS SIMULATION	L	T	P	C
	Total contact hours – 75	3	2	0	4
	Prerequisite				
	Nil				
PURPOSE					
To highlight the basic concepts and procedure for simulation of manufacturing systems.					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	Basics of simulation and its types				
2.	Techniques for generation of random numbers				
3.	Design and evaluation of simulation experiments				
4.	Simulation languages				
5.	Concepts and simulation of discrete events				

UNIT I – INTRODUCTION

(10 hours)

Systems – discrete and continuous systems, general systems theory, models of systems- variety of modeling approach, concept of simulation, simulation as a decision making tool, types of simulation, Principle of computer modeling- Monte Carlo simulation, Nature of computer modeling, limitations of simulation, area of application.

UNIT II - RANDOM NUMBER GENERATION

(15 hours)

Techniques for generating random numbers- mid square method, mid product method, constant multiplier technique, additive congruential method, linear congruential method. Tests for random numbers- Kolmogorov-Smirnov test, the Chi-square test.

UNIT III - DESIGN AND EVALUATION OF SIMULATION EXPERIMENTS

(15 hours)

Problem formulation, data collection and reduction , time flow mechanism, key variables, logic flow charts, starting condition, run size, experimental design consideration, output analysis, verification and validation of simulation models.

UNIT IV - SIMULATION LANGUAGES (15 hours)

Comparison and selection of simulation languages, study of any one simulation language

UNIT V - DISCRETE EVENT SIMULATION (20 hours)

Concepts in discrete –event simulation, development of simulation models for queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network.
Programming for discrete event simulation in GPSS, case studies.

REFERENCES

1. Jerry Banks and John S Carson, Barry L Nelson, David M Nicol, "*Discrete event system simulation*", Prentice Hall, India, 2009.
2. Khoshnevi. B., "*Discrete system simulation*", McGraw Hill International edition,1994
3. Ronald G Askin and Charles R Standridge , "*Modeling and analysis of manufacturing systems*", John Wiley & Sons, 1993.
4. Gordon G , "*System Simulation*", Prentice Hall, India, 1995.
5. Thomas J Schriber., "*Simulation using GPSS*", John Wiley & Sons, 1991.
6. Shannon, R.E., "*System Simulation – The art and science*", Prentice Hall, India, 1993.

ME2207	SENSORS FOR INTELLIGENT MANUFACTURING AND CONDITION MONITORING				
	L	T	P	C	
	Total contact hours – 75	3	0	2	4
	Prerequisite				
Nil					

PURPOSE

To expose the students to different types of Sensors used in manufacturing and fundamentals of condition monitoring.

INSTRUCTIONAL OBJECTIVES

To familiarize

1. Basics of sensors in manufacturing.
2. Different types of sensors in manufacturing.
3. Sensors in CNC machine tools
4. Concepts of condition monitoring and identification.

UNIT I – INTRODUCTION TO SENSORS (9 hours)

Introduction- Role of sensors in manufacturing automation – operation principles of different sensors - electrical, optical, acoustic, pneumatic, magnetic, photo -electric, electro-optical, vision, proximity.

UNIT II - SENSORS IN MANUFACTURING (9 hours)

Sensors in Manufacturing- Industrial sensors - Temperature sensors- Semiconductor absorption sensors, Non-contact sensors, Pyrometers, Pressure sensors- piezoelectric circuit, strain gauges, fiber optic pressure sensors, displacement sensors for robotic applications, Manufacturing of industrial sensors – Semiconductors, Fiber optics sensors and their principles and applications.

UNIT III - SENSORS IN MACHINE TOOLS (9 hours)

Sensors in CNC machine tools – Linear and Angular position sensors, Velocity sensors, Principles and applications.

Sensors in Robots-Position sensors, encoder and revolvers, potentiometers, range proximity touch – torque sensors, Machine vision, Smart sensors.

UNIT IV - CONDITION MONITORING (9 hours)

Condition monitoring of manufacturing systems- Principles, Sensors for monitoring force, Vibration and Noise, selection of sensors and monitoring techniques.

Acoustic Emission: Principles of Acoustic emission sensors, Concepts of pattern recognition, applications of Acoustic emission, on line monitoring of tool wear using Acoustic emission.

UNIT V - IDENTIFICATION TECHNIQUES (9 hours)

Automatic identification techniques for shop floor control, optical character and machine vision sensors, smart / intelligent sensors, integrated sensors, Robot sensors, Micro sensors, Nano sensors.

PRACTICAL – 30 Hours

REFERENCES

1. Jacob Fraden "*Handbook of Modern Sensors physics, designs and applications*" Springer-Verlag New York, 2004.
2. Sabrie Salomon, "*Sensors and control systems in manufacturing*", McGraw Hill Int. Edition, 2010
3. Julian W. Gardner, "*Micro sensor MEMS and Smart Devices*", John Wiley & Sons, 2001.
4. Randy Frank, "*Understanding smart sensors*", Artech House, USA, 2011.
5. Julian W. Gardner, "*Micro sensor principles and applications*", John Wiley & sons, 1994.

ME2208	COMPUTER AIDED INSPECTION AND NON DESTRUCTIVE EVALUATION	L	T	P	C
	Total contact hours – 75	3	0	2	4
	Prerequisite				
	Nil				

PURPOSE	
To highlight the applications of computers in inspection and NDE.	
INSTRUCTIONAL OBJECTIVES	
To familiarize	
1.	Basics of computer aided inspection
2.	Various computer aided inspection devices
3.	Fundamentals of Non Destructive Evaluation and its applications.

UNIT I - COMPUTER AIDED METROLOGY AND MEASURING MACHINES (10 hours)

Metrological concepts – Abbes principle – need for high precision measurements – problems associated with high precision measurements - Computer aided metrology and inspection – principles and interfacing, software metrology, laser metrology, application of lasers in precision measurements – laser interferometer, laser scanners, contact and non-contact type optical and non-optical inspection methods, In process inspection. Use of microprocessors and computers in metrology and inspection, Coordinate Measuring Machine (CMM), Tool Makers Microscope, Image Shearing Microscope, Universal Measuring Machine, etc.,

UNIT II - LIQUID PENETRANT INSPECTION AND SHEAROGRAPHY (8 hours)

Introduction – Principles of penetrant inspection - Characteristics of Liquid penetrants, - Water-washable System – Post-emulsification system – Solvent removable system – Surface preparation and cleaning – Penetrant application – Development Developers – Advantages and limitations - Applications. Shearography-principles-constructions-applications.

UNIT III - MAGNETIC PARTICLE INSPECTION AND ACOUSTIC EMISSION (9 hours)

Introduction – Magnetisation – Magnetisation methods – Continuous and residual methods – Sensitivities – Demagnetisation – Magnetic particles - Applications, Advantages and Limitations

Principles of acoustic emission techniques, instrumentation, applications, advantages and limitations.

UNIT IV - RADIOGRAPHY INSPECTION (9 hours)

Introduction – Uses of radiography – Limitations of radiography – Principles of radiography – Radiation sources – X-Ray production, X-ray Spectra, Properties of X-rays and γ Rays – Attenuation of radiation – Radiographic equivalence – Shadow formation, enlargement and distortion – Radiographic film and paper - Exposure curves and charts, Contrasts – Radiographic screens – Viewing and interpretation of

radiographs – Operational characteristics of X-ray, Equipment, Applications, Advantages, limitations etc.

UNIT V - ULTRASONIC INSPECTION (9 hours)

Introduction – Nature of Sound - Production of Ultrasonic waves, Different types of waves, General characteristics of waves, Pulse echo method, Sound attenuation – Display systems – Probe types and construction – Type of Display – Inspection techniques - Identification of defects – Sensitivity and Calibration - Applications, Advantages and limitations.

PRACTICAL – 30 Hours

REFERENCES

1. Baldev Raj, Jayakumar .T and Thavasimuthu M., '*Practical Nondestructive Testing*', Narosa Publishing House, 2002
2. "*American Society of Metals*", Metals Hand book, Vol. 11, 10th edition, 1998
3. Jain R.K., "*Engineering Metrology*", Khanna Publishers, 1997
4. "*Progress in Acoustic Emission*", Proceedings of 10th International Acoustic Emission symposium, Japanese society for NDT,1990
5. Barry Hull and Vernon John, "*Non Destructive Testing*", Macmillan, 1988
6. Gayler and Shotbolt, "*Metrology for Engineers*", ELBS, 1980
7. www.ndt.org

ME2209	ADVANCED MATERIALS ENGINEERING	L	T	P	C
	Total contact hours – 75	3	0	2	4
	Prerequisite				
	Nil				

PURPOSE

To highlight the materials used in manufacturing and their behaviour under service.

INSTRUCTIONAL OBJECTIVES

To familiarize

- | | |
|----|---|
| 1. | Mechanical behaviour of metals. |
| 2. | Fracture behaviour of metals and failure analysis. |
| 3. | Selection of materials and their applications with case studies. |
| 4. | Fundamentals of modern metallic materials and non metallic materials. |

UNIT I - MECHANICAL BEHAVIOUR (15 hours)

Elastic – Plastic Behaviour in metals, Plastic deformation mechanism, Role of dislocations on plastic deformation, shear strength of perfect and real crystals - strengthening mechanisms – strain hardening / work hardening, Alloying / solid solutioning, Grain boundary strengthening, Poly phase mixture, Precipitation strengthening, Martensite strengthening, Fibre, particle and Dispersion strengthening, - Effect of Temperature, Strain, and Strain Rate on Plastic behaviour – super Plasticity.

UNIT II - FRACTURE BEHAVIOUR AND FAILURE ANALYSIS (15 hours)

Griffith's Theory of Fracture, Stress Intensity factor and Fracture Toughness -Ductile, Brittle Transition in Steel - High Temperature Fracture, Creep - Deformation Mechanism Maps, Fatigue - Low and High Cycle fatigue Test, crack Initiation and Propagation mechanisms and Paris Law - Effect of Surface and Metallurgical parameters on Fracture, Failure Analysis – Procedures and Sources of Failure.

UNIT III - SELECTION OF MATERIALS (15 hours)

Need for the Selection - Cost Basis and Service Requirements - Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep – Selection for Surface durability, Wear Resistance, Corrosion Resistance – Relationship between Material Selection and Processing - Case Studies in Material Selection for Aero, Auto, Marine, Machinery and Nuclear Applications.

UNIT IV - MODERN METALLIC MATERIALS (15 hours)

Dual Phase Steels, Micro Alloyed Steel, High Strength Low Alloy (HSLA)Steel, Transformation Induced Plasticity (TRIP) Steel, Maraging Steel, Intermetallics Ni and Ti Aluminides, Smart Materials, Shape Memory Alloys, Metallic Glass, Quasi Crystal and Nano Crystalline Materials.

UNIT V - NON METALLIC MATERIALS (15 hours)

Polymeric Materials - Structure, Properties and Applications of Engineering Polymers - Advanced Structural Ceramics, WC, TiC, TaC, Al_2O_3SiC , Si_3N_4 , CBN, Diamond, Fibers, Foams, Adhesives and Coatings - Properties, Processing and Applications.

REFERENCES

1. Budinski. G.K. and Budinski. K.M., "*Engineering Materials: Properties and Selection*", 7th Edition, Prentice Hall of India, 2010.
2. Daniel Henkel, Allan Pense, "*Structures and Properties of Engineering Materials*", Tata McGraw Hill Publishers, 2002.
3. Thomas H. Curtney, "*Mechanical Behaviour of Materials*", (2nd Edition), McGraw Hill, 2005.
4. Filnn .R.A. and Trojan .P.K., "*Engineering Materials and their Applications*", (4th Edition), Jai co, 1999.
5. Charles.J.A., and Crane F.A.A., "*Selection and Use of Engineering Materials*", (3rd Edition), Butterworth – Heiremann, 2001.
6. Metals Hand Book, Vol. 10, "*Failure Analysis and Prevention*", (10th Edition), 1994.
7. "*Powder Metallurgy*", Metals Hand Book, Vol. 7, ASM, USA, 1994
8. Lubin. G. Ed., "*Hand Book of composites*", Van Nestrland, Rcishahole, USA, 1994.
9. George .E. Dieter, "*Mechanical Metallurgy*", McGraw Hill, 1988.
10. www.astm.org/labs/pages/131350.htm
11. www.applied materials .com/carrers/agu-ei.html

OPTIONAL / ELECTIVE COURSES (PROGRAM ELECTIVES)

		CONCURRENT ENGINEERING			
L	T	P	C		
3	0	0	3	ME2119	
Total contact hours – 45					
Prerequisites					
Nil					
PURPOSE					
To study the principles of concurrent engineering and how it can be applied.					
INSTRUCTIONAL OBJECTIVES					
1.	To familiarize with the basics of concurrent engineering				
2.	The tools and methodologies available in CE				
3.	Various approaches to CE				
4.	The other related aspects of CE				

UNIT I - INTRODUCTION

(9 hours)

Introduction to Concurrent Engineering – Definitions - Historical Background – Goals of CE - need for CE – Development process with CE Role of CAD/CAM in CE – Product life cycle.

UNIT II - CONCURRENT ENGINEERING TOOLS

(9 hours)

Concurrent Engineering Tools & Techniques – Quality function Deployment – Value function analysis – Failure Mode & Effect Analysis – Design for Manufacture & Assembly – Design for X – Taguchi's Robust Design approach – Pugh process – customer Focused Design – rapid prototyping – simulation.

UNIT III IMPLEMENTATION OF CONCURRENT ENGINEERING

(9 hours)

Implementing CE in an organization – concurrent Engineering Teams – their roles and responsibilities Organizational functions to support CE team environment. Setting Team goals, measuring performance of team & managing a CE Team, Limitations of team.

UNIT IV CONCURRENT APPROACHES TO DESIGN AND MANUFACTURE

(9 hours)

Concurrent approaches to Design & Manufacture – Design for manufacture & Assembly – Design for economics – Design for X – Product Data Management – Agile manufacturing – rapid prototyping & simulation.

UNIT V - CONCURRENT APPROACHES TO OTHER ASPECTS OF ENGINEERING

(9 hours)

Concurrent approaches to other aspects of Engineering - Introduction JIT - Design, development & management for JIT – Implementation of JIT, supply product Life cycle management – Project time management – Techniques of time management. Collaborative product commerce simple case studies in CE.

REFERENCES

1. "Thomas A. *Concurrent Engineering*", Salomone, Maarcel Dekker Inc. New York, 1995.
2. Moustapha .I "*Concurrent Engineering in product Design Development*" New
3. Age International (p) Ltd., 2003.
4. Prasad, "*Concurrent Engineering fundamentals - Integrated Product Development*", Prentice Hall, 1996.
5. Sammy G. Sinha, "*Successful implementation of concurrent product & process*", Wiley, John & Sons, Inc., 1998.
6. Anderson M.M. & Hein L. Berlin, "*Integrated Product Development*", Springer Verlag, 1987.

RAPID PROTOTYPING AND TOOLING		L	T	P	C
ME2122	Total contact hours – 45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To study the modern prototyping tool Rapid prototyping, its types and applications.					
INSTRUCTIONAL OBJECTIVES					
1.	To familiarize the basics of RPT				
2.	The various process in RP				
3.	The principles of Rapid tooling and reverse Engineering				

UNIT I - INTRODUCTION

(9hours)

Definitions, evolution, CAD for RPT. Product design and rapid product development. The cost and effects of design changes during conceptual modeling, detail designing, prototyping, manufacturing and product release. Fundamentals of RPT technologies, various CAD issues for RPT. RPT and its role in modern manufacturing mechanical design. 3D solid modeling software and their role in RPT. Creation of STL or SLA file from a 3D solid model.

UNIT II - LIQUID AND POWDER BASED RP PROCESSES

(9hours)

Liquid based process: Principles of STL and typical processes such as the SLA process, solid ground curing and others - Powder based process: Principles and typical processes such as selective laser sintering and some 3D printing processes.

UNIT III -SOLID BASED RP PROCESSES (9hours)

Principles and typical processes such as fused deposition modeling laminated object modeling and others.

UNIT IV - RAPID TOOLING (9hours)

Principles and typical processes for quick batch production of plastic and metal parts through quick tooling.

UNIT V - REVERSE ENGINEERING (9hours)

3D scanning, 3D digitizing and Data fitting,. High speed machining- Hardware and software - Applications: Evaluation, bench marking and various case studies.

REFERENCES

1. Burns. M, "*Automated Fabrication*", PHI, 1993.
2. Chua. C.K, "*Rapid Prototyping*", Wiley, 1997.
3. Hilton. P.D. et al, "*Rapid Tooling*", Marcel, Dekker 2000.
4. Beaman J.J et al, "*Solid freeform fabrication*", Kluwer, 1997.
5. Jacobs P.F., "*Stereolithography and other Rapid Prototyping and Manufacturing Technologies*", ASME, 1996.
6. Pham D.T. and Dimov S.S., "*Rapid Manufacturing: the technologies and application of RPT and Rapid tooling*", Springer, London 2001.

APPLICATIONS OF COMPUTERS IN MANUFACTURING		L	T	P	C
ME2211	Total contact hours – 45	3	0	0	3
	Prerequisites				
	Nil				

PURPOSE

To highlight different applications of computers in manufacturing

INSTRUCTIONAL OBJECTIVES

To familiarize

- | | |
|----|---|
| 1. | Applications of computers in process design |
| 2. | Applications of computers in precision machining and inspection |
| 3. | Applications of computers in communication as used in manufacturing |

UNIT I - INTRODUCTION (5 hours)

Introduction – computer – Hardware and software – Types and system organization – Applications in Sales forecasting, Marketing – Cost and profit analysis.

UNIT II - PRODUCT CONCEPTS**(10 hours)**

Product Design – Computer Application – Optimization of Product features and Parameters – FEM and FEA Design for quality and cost – Robust design through Computer Programming.

UNIT III - PROCESS DESIGN AND ESTIMATION**(10 hours)**

Process Design – Process Planning and Control – Tool design and Selection – Related software – Computer aided MRP – Scheduling and Control.

UNIT IV - COMPUTERAIDED TECHNIQUES**(10 hours)**

CNC Machining – Part Programming - Micro machines – Precision Manufacturing Systems – CAD/CAM interfacing. Computer Aided Inspection – CMM, AFM, Talysurf Instruments – Quality Control.

UNIT V - COMMUNICATION AND DEVELOPMENTS**(10 hours)**

Networking System – Computer Aided Communication – Feedback – Research and development – Recent developments – Design for productivity – Group technology – Cost estimation.

REFERENCES

1. Groover. M.P., "*CAD/CAM*", Prentice Hall, 1997
2. Pressman, R.S. and William, J.E., "*Numerical Control and CAD*", John Wiley & Sons, Inc. New York, 1997.
3. RadhaKrishnan. P, Subramanyan. S, "*CAD/CAM/CIM*", New Age International Publishers,1994
4. Grahens T Smith, "*CNC Machining Technology*", Springer Verlog, 1993.
5. Yorem Koren, "*Computer Control of Manufacturing System*", McGraw Hill, 1986.

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS IN MANUFACTURING		L	T	P	C
ME2212	Total contact hours – 45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To expose the students to fundamentals of AI and Expert systems and its applications in manufacturing.					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	Fundamental concept of AI and expert system in manufacturing				
2.	Concepts of fuzzy logic, AI programming languages and applications of OOP				
3.	Speech and vision recognition systems for knowledge acquisition for the use of AI and expert system in manufacturing.				

UNIT I - INTRODUCTION

(6 hours)

Introduction: History, Definition of AI, Emulation of human cognitive process, knowledge search tradeoff, stored knowledge, semantic nets. An abstract view of modeling, elementary knowledge. Computational logic, analysis of compound statements using simple logic connectives, predicate logic, knowledge organization and manipulation, knowledge acquisition.

UNIT II - PROGRAMMING AND LOGICS IN ARTIFICIAL INTELLIGENCE (8 hours)

LISP and other programming languages- introduction to LISP, syntax and numerical function, LISP and PROLOG distinction , input output and local variables, Interaction and recursion, property list and arrays alternative languages, formalized symbolic logics- properties of WFRS, non-deductive inference methods.
Inconsistencies and uncertainties- Truth maintenance systems, default reasoning and closed world assumption, Model and temporary logics.

UNIT III - SEARCH METHODS AND KNOWLEDGE REPRESENTATION (9 hours)

Fuzzy logic - concepts, Introduction to Fuzzy logic with examples, probabilistic reasoning, Bayesian probabilistic inference, Dempster Shafer theory, possible world representation, Ad-Hoc methods.
Structure knowledge: Graph, frames and related structures, Object oriented representation- object classes, message and methods, simulation examples using OOPS programs, OOP languages.
Search and control strategies - Concepts, search problems, uniformed or Blined search, searching AND – OR graphs.

UNIT IV - KNOWLEDGE ORGANISATION AN COMMUNICATION IN EXPERT SYSTEMS (11 hours)

Matching techniques- Need for matching, matching problem, partial matching, Fuzzy matching, RETE matching algorithm. Knowledge organization- Indexing and retrieval techniques, integration of knowledge in memory organization systems, Perception, communication and Expert systems. Overview of Linguistics, Basic passim techniques, semantic analysis and representation structures, natural language generation and system.

UNIT V - PATTERN RECOGNITION AND LEARNING TECHNIQUES (11hours)

Pattern recognition system- understanding speech recognition, Image transformation, low level processing, medium and high level processing, vision system architecture, Rule based system architecture, knowledge acquisition and validation, knowledge system building tools, use of AI and ES in manufacturing and design, types of learning- general learning model, performance measures, learning automate genetic algorithm, learning by induction - LEX, ID3, INDUCE systems.

REFERENCES

1. Russel (Stuart), "*Artificial Intelligence- Modern approach*" Pearson Education series in AI, 3rd Edition, 2009.
2. Dan W Patterson, "*Introduction to Artificial intelligence and Expert systems*", Prentice Hall of India Pvt. Ltd, 2001
3. Eugene Charniak, Drew Mc Dermot, "*Introduction to Artificial intelligence*", Addison Wesley Longman Inc., 2009
4. George. F, William. A. Stubblefield, "*Artificial intelligence and the design of expert systems*", The Benjamin Cummins Publishing Co., Inc 2nd Edition, 1992.
5. Robert J Schalkoff, "*Artificial intelligence An Engineering Approach*", McGraw Hill International Edition, 1990.

AUTOMATED MATERIAL HANDLING SYSTEMS		L	T	P	C
ME2213	Total contact hours – 45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To highlight the concepts of automated material handling systems and their applications in manufacturing					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	Fundamentals of automation in material handling				
2.	Common material handling systems				
3.	Automated material handling systems like RGVS, AGVS, AS/RS, etc.,				
4.	Transfer mechanisms, conveyors, part feeding devices, robots in material handling				

UNIT I - INTRODUCTION

(9 hours)

Introduction to work handling concepts in manufacturing – configuration, symbolic representation, work piece characteristics and their significance, Facilities planning process, Facilities design and diagrams, Storage facilities planning, Materials flow, Activity relationship, Space requirements, Facility lay out – computerized lay outs, Evaluation and selection of alternatives, Defined materials handling, Storage – open and closed storage systems, Bulk loading, Unloading, Shipping and Receiving systems and operations.

UNIT II - COMMON MATERIAL HANDLING EQUIPMENTS

(9 hours)

Concepts of Unit Loads, Material handling and Storage equipments operation and selection, Containers, Pallets, Conveyor systems, Industrial trucks, Wagon tippers, Transporters, Stackers, Reclaimers, Silos & hoppers and their accessories, Ropeways, Ship loaders, Cable cranes, Container handling systems, Electric lifts & Hoists, EOT cranes, Elevators, Material handling equipments in Steel mills, Power plants, Mines, Automobile and Transport Industries, Large scale Constructions etc.,

UNIT III - AUTOMATION OF MATERIAL HANDLING

(9 hours)

Automated feeding arrangements for discrete parts, their design based in work piece requirements, orienting methods, one by one feeding, agonizing, stapling etc., - Feeding continuous material liquids, granules etc., - Automated assembly system, elements, configuration design, details and control – Special feeding mechanisms – Automated inspection and their design

UNIT IV - CLASSIFICATION OF AUTOMATED SYSTEMS

(9 hours)

Concepts of Unit Built Machines (UBM) – classification and elements, Power Units, self-contained and separate feed type, Change over UBMs, Transfer lines – classification and their components, Automated systems for handling and transfer of prismatic, axis symmetric parts and asymmetric parts in transfer lines, Case studies on transfer lines – interlocked, palletized and flexible inter linkage transfer lines, control systems – SWARF handling and disposal systems.

UNIT V - AUTOMATED MATERIAL HANDLING EQUIPMENTS (9 hours)

Automated handling and storage systems in manufacturing environment, Rail Guided Vehicles (RGVs), Automated Guided Vehicles (AGVs), Applications of RGVs and AGVs, Automated Storage and Retrieval Systems (AS / RS), AS / RS in the Automated factory, Considerations for planning an AS /RS system, Applications of AS / RS, Principles of work holding devices – Modular fixturing, Flexible fixturing systems – Fixturing for FMS, Robots and their applications in handling and storage.

REFERENCES

1. Groover. M. P., "Automation, Production Systems and CIM", Prentice hall India, 2007.
2. Morris A. Cohen, Uday M. Apte., "Manufacturing Automation", Irwin, Chicago, 1997.
3. Ray Asfahl. C., "Robots and Manufacturing Automation", 2nd edition, John Wiley & Sons, New York, 1992.
4. James A. Tompkins., "Facilities planning", John wiley & Sons Inc, 1984.
5. James. M. Apple, "Principles of layout and material handling", Ronald press, 1977.

		COMPUTER AIDED PROCESS PLANNING			
ME2214	Total contact hours – 45	3	0	0	3
	Prerequisites				
	Nil				
	PURPOSE				
To provide the importance of Computer Aided Process Planning and steps involved in its implementation					
INSTRUCTIONAL OBJECTIVES					
This subject impregnates					
1.	Concepts and to plan the various processes involved in manufacturing				
2.	Modern approaches in generative approach				
3.	AI and expert systems in planning the processes				
4.	Various process planning systems				

UNIT I - INTRODUCTION (9 hours)

Process Planning, approaches to process planning, Study of a typical process planning, role of process planning in CAD / CAM integration, Concurrent Engineering.

UNIT II - PART DESIGN REPRESENTATION (9 hours)

Tolerance concepts, geometric tolerancing, drafting practices in dimensioning and tolerancing, geometric transformation, data Structure. GT coding - DCLASS, OPITZ system, MICLASS system

UNIT III - PROCESS PLANNING (9 hours)

Decision tables and decision Trees – process planning, variant process planning, generative process planning. Artificial intelligence in process planning, Geometric modeling for process planning – process capability analysis.

UNIT IV - COMPUTER AIDED PROCESS PLANNING SYSTEMS (9 hours)

Logical Design of Process Planning – Manufacturing System component, Production Volume, Production families – CAM I's CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP

UNIT V - GENETIC ALGORITHM AND INTEGRATED PROCESS PLANNING SYSTEMS (9 hours)

Genetic algorithm in CAPP, Practical use of CAPP in real Manufacturing area, Expert systems, Fuzzy Logic in Process Planning, Totally integrated process planning and Case study.

REFERENCES

1. Rao, "*Computer Aided Manufacturing*", Tata McGraw Hill Publishing Company, 2000
2. Nanua Singh, "*Systems approach to Computer integrated Design and Manufacturing*", John Wiley & sons, 1996.
3. Gideon Halevi and Rol and. D. Weill, "*Principles of Process Planning, A logical approach*", Chapman & Hall 1995.
4. Tien – Chien Chang, Richard. A. Wysk, "*An introduction to Automated process planning system*", Prentice Hall, 1985.

ME2215	DESIGN FOR MANUFACTURE AND ASSEMBLY	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To enable the students to understand the Design for manufacture and assembly					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	DFM approach and Processes				
2.	Selective assembly				
3.	Datum systems				
4.	Form design of castings and weldments				

UNIT I - EMBODIMENT DESIGN

(9 hours)

Steps, basic rule, principles, guidelines, design for ease of assembly, design for standards, design for maintenance; recycling; minimum risk; evaluating embodiment design. Design for minimum cost, DFM approach and Processes, DFM guidelines, DFMEA, PFMEA.

TOLERANCE ANALYSIS: Process capability, mean, variance, skewness, kurtosis, process capability metrics, Cp, Cpk cost aspects, feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances- sure fit law, normal law and truncated normal law.

UNIT II - SELECTIVE ASSEMBLY

(10 hours)

Interchangeable past manufacture and selective assembly, deciding the number of groups- Model-I: Group tolerances of mating parts equal; Model-II: total and group tolerances of shaft equal. Control of axial play – introducing secondary machining operations, laminated shims, examples.

DATUM SYSTEMS: Degrees of freedom, grouped datum systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped datum system with spigot and recess pair and tongue – slot pair computation of translational and rotational accuracy, geometric analysis and applications.

UNIT III - TRUE POSITION THEORY

(9 hours)

Comparison between co-ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples.

UNIT IV - FORM DESIGN OF CASTINGS AND WELDMENTS

(9 hours)

Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members using weldments, use of welding symbols.

TOLERANCE CHARTING TECHNIQUE:

Operation sequence for typical shaft type of components. Preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples. Design features to facilitate machining; datum features – functional and manufacturing. Component design – machining considerations, redesign for manufacture, examples.

UNIT V - CASE STUDIES

(8 hours)

Redesign to suit manufacture of typical assemblies, tolerance design of a typical drive – system, example, design of experiments. Value analysis and design rules to minimize cost of a product. Computer Aided DFMA, Poke Yoka principle.

REFERENCES

1. Harry Peck, "*Designing for Manufacture*", Pitman Publications, 1983.
2. G. Boothroyd, Peter Dewhurst, Winston Anthony Knight, "*Product Design for Manufacture and Assembly*", CRC press, 2011.
3. Matousek, "*Engineering Design – A systematic Approach*" Blackie & Son Ltd. London, 1974.
4. Ken Wallace, Lucienne T.M. Blessing, "*Engineering Design – A systematic Approach*" Springer, 2007
5. SPOTTS, M.F., "*Dimensioning and Tolerance for Quantity Production*", prentice Hall Inc., 1983.
6. Oliver R Wade, "*Tolerance Control in Design and manufacturing*" Industrial Press Inc., New York, 1967.
7. James G Bralla, "*Hand book of Product Design for Manufacturing*", McGraw Hill Publication, 1983.
8. Trucks, H.E., "*Design for Economic Production*", Society of manufacturing Engineers, Michigan, 2nd Edition, 1987.
9. Poka – Yoke, '*Improving Product Quality by Preventing Defects*', Productivity Press, 1992.
10. Creveling C.M., "*Tolerance Design – A Hand Book for Developing Optimal Specifications*", Addison Wesley Longman, Inc, 1997.

ME2216	DESIGN OF EXPERIMENTS	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To enlighten the students about the fundamentals of design of experiment Techniques					
INSTRUCTIONAL OBJECTIVES					
At the end of this course the student should be able to understand the					
1.	Introduction about design of experiments				
2.	Response surface design				
3.	Factorial design				
4.	Taguchi design				
5.	ANOVA analysis				

UNIT I - INTRODUCTION

(9 hours)

Design of experiments-Introduction, factor constraints, Interaction terms, Number of runs, enter data, analyze the data, level of factors, Custom designs-Introductions, examples, Screening design creation- Statistical Software introduction, demo using simple case studies.

UNIT II - RESPONSE SURFACE DESIGN

(9 hours)

Response surface design-Introduction, creation, Central Composite Design, Box Behnken design, Contour profile of response surface plot, Design table, analyze the data, using Statistical software simple case study examples-Evolutionary operation, Experiment with random factor-Simple case studies.

UNIT III - FACTORIAL DESIGN

(9 hours)

Basic definition, principles and advantages-Creating, Blocking in a factorial design, responses and factors, Simple case studies, 2-level fractional factorial design, Mixture design- Introduction, optimal mixture design, Simplex centroid design- examples, 2^k Factorial design, linear Regression analysis- error prediction, Full factorial design-Simple Case studies.

UNIT IV - TAGUCHI DESIGN

(9 hours)

Creating Taguchi design approach, Orthogonal array, S/N Ratio, Smaller is better, nominal is better and Larger is better, with simple case studies, analyze the data-Factor effect diagram, Levels of parameters, Confirmation test-Augmented design, simple case study problems.

UNIT V- ANOVA ANALYSIS**(9 hours)**

Experimentation with single factor- Analysis of Variance-Sum of square -Determining sample size-Model adequacy checking-Regression approach-least square method- Non parametric method- Simple problems.

REFERENCES

1. Douglas C Montgomery, "*Design and analysis of experiments*", John Wiley & Sons, Ltd., 5th edition, 2005.
2. JMP. "*Design of Experiments*", SAS Institute Inc., Cary, NC, USA, 2005, ISBN 1-59047-816-9.
3. Box, G.E.P. and Draper, N.R., "*Empirical Model-Building and Response Surfaces*", New York: John Wiley and Sons, 1987.
4. Box, G.E.P., Hunter. W.G., and Hunter, J.S., "*Statistics for Experimenters*", New York: John Wiley and Sons, Inc., 1978.
5. John, P.W.M., "*Statistical Design and Analysis of Experiments*", New York: Macmillan Publishing Company, Inc., 1972.
6. Myers, R.H., "*Response Surface Methodology*", Boston: Allyn and Bacon, 1976.
7. Jiju Antony, "*Design of Experiments for engineers and Scientist*", Elsevier, 2003.
8. Z.R.Lazic, "*Design of experiments in chemical engineering: A practical guide*", Wiley, 2005.
9. Cox.C.R., "*The theory of Design of Experiments*", Chapman and Hall, CRC press, 2000.

		FLEXIBLE MANUFACTURING SYSTEMS			
ME2217	Total contact hours – 45	L	T	P	C
		3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To introduce the basics and components of FMS to the learners					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	Basic concepts and components of FMS				
2.	Automated material handling systems used in FMS				
3.	FMS control using computers				
4.	Software used in FMS & scheduling of FMS				

UNIT I - FMS INTRODUCTION**(9 hours)**

Definition of an FMS-need for FMS, types and configuration, types of flexibilities and performance measures. Economic justification of FMS. Development and implementation of FMS- planning phases, integration, system configuration, FMS layouts, simulation.

UNIT II -AUTOMATED MATERIAL HANDLING AND STORAGE**(9 hours)**

Functions – types - analysis of material handling systems, primary and secondary material handling systems-conveyors, Automated Guided Vehicles-working principle, types, traffic control of AGVs. Role of robots in material handling. Automated storage systems- storage system performance – AS/RS-carousel storage system, WIP storage systems, interfacing handling and storage with manufacturing.

UNIT III - COMPUTER CONTROL OF FMS (9 hours)

Planning, scheduling and computer control of FMS, Hierarchy of computer control, supervisory computer. DNC system- communication between DNC computer and machine control unit, features of DNC systems.

UNIT IV - COMPUTER SOFTWARE, SIMULATION AND DATA BASE OF FMS (9 hours)

System issues, types of software – specification and selection- trends-application of simulation and its software, Manufacturing Data systems- planning FMS data base. Modeling of FMS- analytical, heuristics, queuing, simulation and petrinets modeling techniques.

UNIT V - SCHEDULING OF FMS (9 hours)

Scheduling of operations on a single machine- two machine flow shop scheduling, two machine job shop scheduling, - three machine flow shop scheduling- scheduling 'n' operations on 'n' machines, knowledge based scheduling, scheduling rules, tool management of FMS, material handling system schedule.

REFERENCES

1. Jha. N.K., "*Hand Book of Flexible Manufacturing Systems*", Academic Press Inc,1991
2. Raouf, A. and Ben-Daya, M., Editors, "*Flexible manufacturing systems: recent development*", Elsevier Science, 1995.
3. Parish.D.J., "*Flexible Manufacturing*", Butter worth-Heinemann Ltd,1990.
4. Groover. M. P., "*Automation production systems and computer integrated manufacturing*", Prentice hall of India pvt.Ltd, 1989.
5. Taiichi Ohno, "*Toyota production system: beyond large-scale production*" Productivity Press (India) Pvt. Ltd. 1992.
6. Buffa .E.S. and Sarin, "*Modern Production and Operations Management*", Wiley Eastern, 1987.
7. Radhakrishnan P. and Subramanyan S., "*CAD/CAM/CIM*", Wiley Eastern Ltd.,New Age International Ltd., 1994.

ME2218	GROUP TECHNOLOGY AND CELLULAR MANUFACTURING	L	T	P	C
	Total contact hours – 45	3	0	0	3

	Prerequisites				
	Nil				
PURPOSE					
To emphasize the importance of group technology and cellular manufacturing systems and their significance & impact in manufacturing areas.					
INSTRUCTIONAL OBJECTIVES					
At the end of this course the student should be able to understand					
1.	Basics of Group technology				
2.	Concepts and applications of Cellular manufacturing systems				
3.	Traditional and non-traditional approaches of Problem solving				
4.	Implementation of CMS				
5.	Performance measurement and Human and economical aspects of CMS.				

UNIT I - INTRODUCTION TO GROUP TECHNOLOGY (7 hours)

Limitations of traditional manufacturing systems, Group technology - design attributes, manufacturing attributes, part families, characteristics and design of groups, PFA, FFA, benefits of GT and issues in GT.

UNIT II - CELLULAR MANUFACTURING (8 hours)

Introduction, types of manufacturing cell, Design of cellular manufacturing systems, determination of best cell arrangement, key machine concept. Cell formation approach- Machine component group analysis, similarity coefficient based approach, exceptional parts and bottleneck machines

UNIT III - PLANNING AND DESIGN OF CELLULAR MANUFACTURING SYSTEM (10 hours)

Problems in GT/CMS - Design of CMS - Models, traditional approaches and nontraditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

UNIT IV - IMPLEMENTATION OF GT/CMS (10 hours)

Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT V - PERFORMANCE MEASUREMENT AND CONTROL (10 hours)

Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework. Economics of GT/ Human aspects of GT/CMS.

REFERENCES

1. Askin, R.G. and Vakharia, A.J., G.T " *Planning and Operation, in the automated factory-Hand Book: Technology and Management*", Cleland.D.I. Bidananda,B (Eds), TAB Books , NY, 1991.
2. Kamrani, A.K, and Nasr, E.A. (Eds), " *Collaborative Engineering: Theory and Practice Springer science*" business media, 2008.
3. Irani.S.A., " *Hand book of Cellular manufacturing system*", John Wiley & sons, 1999.
4. Manua Singh, " *Systems approach to Computer Integrated Design and Manufacturing*", John Wiley & Sons Inc, 1996.

MACHINE VISION AND ITS APPLICATIONS		L	T	P	C
ME2219	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To impart basic knowledge of Image processing and its application in manufacturing engineering.					
INSTRUCTIONAL OBJECTIVES					
To make the student					
1.	to understand Basic principle of machine vision concept and its role in industries				
2.	to understand Fundamentals of image processing, image enhancement,				
3.	to understand object recognition and texture detection				
4.	to understand Dynamic and 3D vision				
5.	to program to detect, localize and recognize image features				

6.	to understand Basic principle of machine vision concept and its role in industries
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UNIT I - INTRODUCTION TO MACHINE VISION (6 hours)

The Nature of Vision- Advantages of Machine vision - Applications of machine vision- image acquisition Principles and Devices-Variou s lighting techniques-Key stages in Image Processing Techniques

UNIT II - IMAGE ENHANCEMENT (12 hours)

Discretization, Neighbours of a pixel-connectivity- Distance measures - preprocessing Neighbourhood averaging, Median filtering. Smoothing of binary Images- Image Enhancement- Histogram Equalization-Histogram Specification –Local Enhancement- Edge detection- Gradient operator-Laplace operators-Thresholding-Morphological image processing

UNIT III - OBJECT RECOGNITION AND FEATURE EXTRACTION (9 hours)

Image segmentation- Edge linking-Boundary detection-Region growing-Region splitting and merging- Boundary Descriptors-Freeman chain code-Regional Descriptors- recognition-structural methods-Statistical and Model based analysis of Texture

UNIT IV - 3D AND DYNAMIC VISION (9 hours)

Photometric stereo. Dynamic Vision - Segmentation using Motion and Moving camera Motion

UNIT V - MACHINE VISION APPLICATION (9 hours)

The GM consight I system-National Bureau of standards vision system- SRI industrial vision system- Image Processing techniques implementation through Image Processing software-MATLAB/OPENCV.

REFERENCES

1. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck, M ACHINE VISION, Published by McGraw-Hill, Inc., ISBN 0-07-032018-7, 1995
2. E.R.Davies, "*Computer and Machine Vision, Theory, Algorithms and Practicalities*", 4th edition, Academic Press
3. RafelC.Gonzalez, Richard E.Woods, StevenL.Eddins, "*Digital Image Processing using MATLAB*", 2nd edition, Tata McGrawHill,2010
4. M.P.Groover, "*Industrial robotics- Technology, programming and Applications*", McGraw-Hill, 1986
5. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "*Robotics: Sensing, Vision & Intelligence*", Tata Mcgraw-Hill Publication, 1987.

6. Richard D.Klafter, Thomas A.Chmielewski, Michael Negin, "Robotic Engineering An Integrated Approach", Prentice Hall India,1989

MANUFACTURING PLANNING AND CONTROL		L	T	P	C
ME2220	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To emphasis the importance of planning and control of different activities in manufacturing.					
INSTRUCTIONAL OBJECTIVES					
To understand					
1. Acquisition of raw materials to delivery of completed products					
2. Key management interfaces and activities					
3. The various optimized production techniques					

UNIT I - MANUFACTURING PLANNING AND CONTROL AND MRP (7 hours)

Frame work for the MPC system - the system and the frame work, Material flows, Individual firm. MRP in MPC: MRP and MRP II: Basic MRP record, Linking MRP records, Scheduled receipts versus planned order releases, MRP planner, MRP system output, MRP Database.

UNIT II - SHOP FLOOR CONTROL, JUST IN TIME AND MPS (9 hours)

Shop Floor Control Techniques – Basic Shop floor control concepts – Gantt charts. Just in Time – Major elements of JIT – JIT corner stones and the linkages to MPC, Master production scheduling techniques, Bill of material structuring for the MPS.

UNIT III - PRODUCTION PLANNING AND DEMAND MANAGEMENT (10 hours)

Production planning – Production planning and management, MPC systems – Routinizing Production & Game planning – Controlling the production plan – operating production planning systems. Demand Management in MPC systems-Demand management and production planning, MPS,- Demand management techniques. Advanced concepts in MRP-Determination of manufacturing order Quantities – EOQ, POQ, PPB, MOM. Two level master scheduling.

UNIT IV - FORECASTING SYSTEMS AND DRP (10 hours)

Forecasting perspectives-Forecast Evaluation, Basic forecasting techniques, Focus forecasting. Independent versus dependent demand items - Functions of inventory - Measuring Inventory performance – routine inventory Decisions. Distribution Requirements Planning in MPC systems- DRP and the market place, Demand management , MPS, DRP techniques.

UNIT V - OPTIMISED PRODUCTION TECHNOLOGY AND IMPS SYSTEMS (9 hours)

Optimized Production Technology – Basic concepts of OPT, OPT and the MPC frame Work. IMPS system – Architecture - Relationships to MPC systems – IMPS netting logic – Expert systems.

REFERENCES

- 1 Thomas E. Vollmann, William L.Berry, D Clay Whybark, "*Manufacturing planning & control systems*", Galgotia Publications (P) Ltd., 1999.
- 2 Samuel Ellen, "*Elements of production planning and control*", Mcmillan& Co., 1971
- 3 Surender Kumar, "*Industrial Engineering and Management of manufacturing systems*", SatyaPrakashan Tech India Publications, 1997
- 4 Ahuja. K.K. "*Production Management*", CBS Publishers, 2004.

		PRODUCTION AND OPERATION MANAGEMENT			
		L	T	P	C
ME2221	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To enlighten the students about the objectives and activities of Production and Operation management.					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	Basics of production and operations management				
2.	Forecasting, Facility location and layout				
3.	MPS and inventory control, scheduling and controlling project management				
4.	Modern production management tools				

UNIT I - INTRODUCTION (9hours)

Functional sub systems if organizations, Systems concept of production, Types of production systems, Productivity, Strategic management.

Product Design and Analysis: New product development, Process Planning and Design, Value analysis and Value Engineering, Standardization, Simplification, Make or Buy decisions, Ergonomic considerations in Product design.
Capacity Planning and Investment Decisions: Capacity planning and strategies, Investment formulas and comparisons of alternatives.

UNIT II - FORECASTING AND FACILITY LOCATION AND LAYOUT (9hours)

Forecasting: Introduction, Nature and use of forecasting, Measures of Forecasting, factors affecting forecasting, Types and models of forecasting.

Facility Location and Lay out: Factors influencing plant location, location evaluation methods, Different types of lay outs for operations and production, arrangement of facilities within the department, CRAFT, ALDEP, CORELAP etc.,

UNIT III - MPS AND INVENTORY CONTROL (9 hours)

Aggregate Planning and Master Production Scheduling: Nature of aggregate planning, Methods of aggregate planning, Approaches to aggregate planning – graphical, empirical and optimization, Development of MPS, MRPI and MRPII.

Inventory Analysis and Control: Definitions, ABC inventory systems, Inventory modals, EOQ models for purchased and manufactured parts, lot sizing techniques.

UNIT IV - SCHEDULING AND PROJECT MANAGEMENT (10 hours)

Scheduling and Controlling: Objectives in scheduling, Major steps involved, Information systems linkages in production planning and control , Production control in repetitive, batch / flow shop and job shop scheduling environment - SPT, EDD, WMFT.

Project Planning and Management: Phases of project planning, Evolution of network planning techniques - Critical Path Method (CPM) and Project Evolution and Review Technique (PERT), Crashing of project network, Project scheduling with constrained resources – RLT & RAT, Graphical Evolution and Review Technique (GERT), Project monitoring, Line balance.

UNIT V - MODERN PRODUCTION MANAGEMENT TOOLS (8 hours)

Just In Time (JIT) – Introduction, elements, pull and push method, KANBAN systems, Small lot size, quick inexpensive set up, Continuous improvement, optimized production technology, CIM and FMS, Benefits and Scope of TQM, Factors affecting quality and Quality control activities in product cycle and ISO 9000 series – Scope and Benefits.

REFERENCES

1. Panneerselvam. R., "*Production and Operations Management*", Prentice Hall India, 2012.
2. Vollman.T.E., "*Manufacturing Planning & Control Systems*", McGraw-Hill, 2005.

3. Dilworth. B. James., "*Operations Management – Design, Planning and Control for Manufacturing and services*", McGraw Hill Inc., New Delhi, 1992.
4. Bedworth D.D., "*Integrated production control systems: management, analysis, design*", John Wiley & sons, New York, 1987.

ME2222	ROBOTICS AND ROBOT APPLICATIONS	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To enlighten the students about the engineering aspects of Robots and their applications.					
INSTRUCTIONAL OBJECTIVES					
At the end of this course the student should be able to understand					
1. The basic concepts of robots					
2. End effectors and control systems					
3. Robot Transformations and Sensors					
4. Robot programming					
5. Robot Industrial applications					

UNIT I - INTRODUCTION

(9 hours)

Introduction to Robotics, Basic concepts- Robot anatomy, Manipulators- Robot kinematics – Direct and inverse kinematics – 2 and 3 DOF of kinematics analysis- Robot trajectories, Precision and accuracy of robot-simple problems. Robot specifications and Work volume, Robot drive system.

UNIT II - END EFFECTORS AND ROBOT CONTROLS

(9 hours)

End effectors- classification – mechanical, magnetic, vacuum and adhesive gripper-gripper force analysis and design. Basic robot motions -Point to point control, continuous path control. Robot control unit - non-servo and servo control of robot joints, adaptive and optimal control.

UNIT III - ROBOT TRANSFORMATIONS AND SENSORS

(9 hours)

2D and 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensor devices, Types of sensors- position and displacement sensors, Force and torque sensors-Proximity and range sensors, acoustic sensors, Robot vision systems.

UNIT IV - ROBOT PROGRAMMING

(9 hours)

Robot language classification – programming methods- off and on line programming, lead through programming- Coordinate systems of Robot, Robot controller functions,

Interlock commands- using WAIT and SIGNAL command for simple applications. VAL language commands-simple programs.

UNIT V - INDUSTRIAL APPLICATIONS

(9 hours)

Application of robots- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting, mobile robot and undersea robot-Micro and nanorobot, Swam robot, Biomimetic Robot- Safety considerations of robot.

REFERENCES

1. Deb. S. R. "*Robotics technology and flexible automation*", Tata McGraw Hill publishing company limited, 1994
2. Mikell. P. Groover, "*Industrial Robotics Technology*", Programming and Applications, McGraw Hill Co, 1995.
3. Klafter. R.D, Chmielewski.T.A. and Noggin's., "*Robot Engineering : An Integrated Approach*", Prentice Hall of India Pvt. Ltd.,1994.
4. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "*Robotics control, sensing, vision and intelligence*", McGraw Hill Book co, 1987.
5. Craig. J. J. "*Introduction to Robotics mechanics and control*", Addison- Wesley, 1999.
6. Ray Asfahl. C., "*Robots and Manufacturing Automation*", John Wiley & Sons Inc., 1985.

ME2223	SUPPLY CHAIN MANAGEMENT	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To introduce the basics of Supply Chain Management and its components in manufacturing industry					
INSTRUCTIONAL OBJECTIVES					
To familiarize					
1.	Concept of SCM, its logistics, basic tasks and various processes				
2.	Strategy resource management, manufacturing strategy and linking supply chain with customer				
3.	Structuring the supply chain				
4.	Organise supply chain with ERP, CRM, etc.,				
5.	Software used for SCM				

UNIT I - SCM – AN INTRODUCTION

(10 hours)

Introduction to Supply Chain Management, Logistics- concept, definition, approaches, factors affecting logistics. Supply Chain – basic tasks of Supply chain – the new corporate model, The new paradigm, the modular company, the network relations, supply process, procurement process – distribution management.

UNIT II - STRATEGY RESOURCE MANAGEMENT (10 hours)

Strategy Resource Management – definition, understanding, nomenclature, tools and techniques. Manufacturing strategy stages, Supply chain progress, model for competing through Supply chain management – supply chain redesign – Linking supply chain with customer.

UNIT III - SUPPLY CHAIN ACTIVITY SYSTEMS (10 hours)

Structuring the supply chain, supply chain and new products, functional roles in supply chain, supply chain design frame work, collaborative product commerce, outsourcing – to make or to buy

UNIT IV -SCM ORGANIZATION AND INFORMATION SYSTEM (10 hours)

The management task, logistics organization, the logistics information systems – topology of supply chain application, ERP, CRM, JIT, Warehouse management system, product data management.

UNIT V - COORDINATING SUPPLY CHAINS WITH E-BUSINESS (5 hours)

Factors influencing coordination – building strategic partnerships and trust – Impact of E Business on supply chain performance – Setting up E-Business in practice.

REFERENCES

1. Schary, P.B., Lasen, T.S., "*Managing the Global Supply Chain*", Viva Books, New Delhi 2000,
2. Ayers, J.B., "*Hand book of Supply Chain Management*", The St, Lencie press, 2000
3. Nicolas, J.N., "*Competitive manufacturing management – continuous improvement, Lean production, customer focused quality*", McGraw-Hill, NY, 1998.
4. Steudel, H.L., and Desruelle, P., "*Manufacturing in the Nineties – How to become a mean, lean and world class competitor*", Van Nostrand Reinhold, NY, 1992.

ME2224	SUSTAINABLE GREEN MANUFACTURING	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
The course aims to introduce and explain the design concepts, methods, tools and technologies, and operations of sustainable lean and green manufacturing systems and processes.					
INSTRUCTIONAL OBJECTIVES					
After completion of this course, the students will obtain knowledge in					
1.	Green Manufacturing and Sustainable engineering concepts				
2.	Multi attributes decision making methods				
3.	Green manufacturing management.				
4.	Applications in green manufacturing				

UNIT I - INTRODUCTION TO GREEN MANUFACTURING (9 hours)

Definition of manufacturing, impact of manufacturing in environmental ecology, role of manufacturing sector in national growth, Technological change and evolving risk, concepts of "green" manufacturing need of green manufacturing, green manufacturing strategies, motivation, barriers, regulation, policy, advantages and limitations of green manufacturing.

UNIT II - GREEN MANUFACTURING TOOLS (9 hours)

Principles of green manufacturing and its efficiency, green manufacturing and sustainability, System model architecture and module, design and planning, control or tools for green manufacturing (Qualitative Analysis, Consumption Analysis, Life Cycle Analysis, Efficiency, Sustainability tools). Standards for green manufacturing (ISO 14000 and OHSAS 18000), waste stream mapping and application, Identify and apply the concepts of product and process design with environmental forethought, Design

for environment and for sustainability Discuss the Product Life Cycle of manufactured goods.

UNIT III - ATTRIBUTES DECISION MAKING METHODS (9 hours)

Introduction to Multi attributes decision making methods, definition, structure, variants and analysis of different methods like Simple Additive Method (SAM), Weighted Product Method (WPM), Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Grey Relation Analysis (GRA), Elimination and Choice Expressing Reality (ELECTRE), and VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), problems based on different MADMs.

UNIT IV - CREATING LEAN AND GREEN ORGANISATION (9 hours)

Question wasteful practices, Gain lean and green endorsement, collaboration to achieve lean and green goals, track progress for environment and profits, creation of sustainable growth, Enabling techniques for assuring green manufacturing, Drivers of green manufacturing, impact, advantages and disadvantages of drivers, Green architecture and buildings, Sustainable manufacturing resources management, Carbon footprint analysis and management of manufacturing processes, Green Process Economics, Resource Recovery and Reuse.

UNIT V - CASE STUDIES IN GREEN MANUFACTURING (9 hours)

Design resources saving into product and processes, closed loop production system, Green manufacturing through clean energy supply, semi conductors manufacturing, green packaging and supply chain, Environmental implication of nano manufacturing.

REFERENCES

1. Charles Wankel "*21st century management : a reference handbook*" SAGE Publications, Inc., 2008.
2. Christian N. Madu "*Handbook of environmentally conscious manufacturing*" London : Kluwer Academic Publishers, 2001.
3. T.E. Graedel& B.R. Allenby "*Industrial Ecology*" Pearson Education, Inc. 2003.
4. Joseph Sarkis "*Greener manufacturing and operations: from design to delivery and back*" Greenleaf Pub., 2001.
5. Ranky, P.G.: "*An Introduction to Alternative Energy Sources: An interactive multimedia 3D eBook publication by CIMware USA, Inc. and CIMware Ltd., UK, ISBN 1-872631- 97-5, 2008.*
6. Ranky, P.G.: "*Digital Product Design: Design For Quality, Manufacturing, Assembly & Disassembly Principles, and an Inkjet Printer Disassembly Use Case*", DVD videopublication by CIMware USA, Inc. and CIMware Ltd., UK, 2008, UPC 632568002983
7. Ranky, P.G.: "*Digital Product Design: Concurrent Engineering Principles, Analysis and Some Tools of Design For Quality, Manufacturing, Assembly &*

Disassembly, and a Desktop Telephone Disassembly Use Case, DVD duo video and 3D eBook publication by CIMware USA, Inc. and CIMware Ltd., UK, 2008, UPC 632568003034

8. Graedel T. E. and Braden R. Allenby, "*Industrial Ecology and Sustainable Engineering*" by 1st edition, Copyright 2010 (ISBN 9780136008064, publisher: Prentice Hall).
9. Liker, Jeffrey. "*The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*". McGraw-Hill, 2004
10. Palevich, Robert. "*The Lean Sustainable Supply Chain: How to Create a Green Infrastructure with Lean Technologies*", FT Press, 2012
11. Womack, James and Jones, Daniel. "*Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Revised and Updated*". Free Press (a division of Simon & Schuster), 2003.
12. Ingrassia, Paul and White, Joseph. "Comeback: *The Fall and Rise of the American Automobile Industry*", Simon& Schuster, 1995.
13. David A. Dornfeld, "*Green manufacturing fundamentals and application*", Springer Publication, (2012)
14. Ame, "*Green manufacturing case studies in lean and sustainability*", productivity press publication (2007)
15. Pamela J Gordon, "*Lean and green profit for your workplace and the environment*", Berrett-Koehler publication, (2001)

ME2225	TOTAL QUALITY SYSTEMS AND ENGINEERING				L	T	P	C
	Total contact hours – 45	3	0	0	3			
	Prerequisite							
	Nil							
PURPOSE								
To explain basic quality concepts of TQM, its tools and techniques used in engineering.								
INSTRUCTIONAL OBJECTIVES								
To familiarize								
1.	Various theories about TQM							
2.	Planning and manufacturing for quality, its tools and techniques							
3.	Supporting tools and techniques for TQM							
4.	Human involvement for quality							
5.	Failure patterns and preventive maintenance							

UNIT I - BASIC CONCEPTS

(10 hours)

Evolution of total quality management, Theories of quality – Deming, Cross by, Juran, Taguchi, Ishikawa. Inspections- Quality Control – TQM system – Human component service and product quality – Consumer orientations.

UNIT II - QUALITY PLANNING**(9 hours)**

Quality of design – concepts in design, Tasks of design, attributes of good design, approaches- Design procedure – product development and manufacturing for quality, process control, C_{pk} , 5S, Process capability, Data base approach.

UNIT III - SUPPORTING TOOLS AND TECHNIQUES**(10 hours)**

Affinity diagram, Bar chart, Block diagram, Brain storming, Cause and effect analysis, Customer supplier relationship checklist, Decision analysis flow charts, Force field analysis, Line graph/Run charts, Pareto analysis, Quality costing, DOE, EMA,QFD, TOPS-8D, Quality project approval and problem solving process.

UNIT IV - HUMAN DIMENSION AND SYSTEM DEVELOPMENT IN TQM (9 hours)

TQM Mindset, Participation style, Team work: Team development, quality circle, motivational aspects, change management. Documentation structure – Information system - ISO 9000, ISO 14000, QS 9000, Certification clauses, procedure.

UNIT V - TOTAL PREVENTIVE MAINTENANCE (TPM)**(7 hours)**

Total preventive Maintenance, Failure patterns, Costs and Benefits, Zero defect. Implementation guidelines – Cost of Poor safety – implementation total safety system – Zero risk.

REFERENCES

1. Arora. K.C., "*TQM and ISO 14000*", S.K. Kataria & sons, New Delhi, 2000.
2. Joel, E. Rose, "*Total Quality Management*", Kogan Page Ltd., USA, 1993.
3. Mohamed Zairi, "*Total Quality Management for Engineers*", Wood hard Publishing Ltd., 1991.
4. Juran J.M, Frank M. Gryna, "*Quality planning and analysis*", 3rd Edition, McGraw Hill, 1993.

SUPPORTIVE COURSES

MA2006	COMPUTATIONAL METHODS IN ENGINEERING	L	T	P	C
	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

To develop analytical capability and to impart knowledge in Mathematical and Statistical methods and their applications in Engineering and Technology and to apply these concepts in engineering problems they would come across.

INSTRUCTIONAL OBJECTIVES

At the end of the course, Students should be able to understand Mathematical and

Statistical concepts and apply the concepts in solving the engineering problems.

UNIT I - INITIAL AND BOUNDARY VALUE PROBLEMS (9 hours)

Classification of Linear differential equation - solution of initial and boundary value problems. Laplace transform methods for one - dimensional wave equation - Displacements in a string. Fourier series methods for one dimensional wave equation and one - dimensional heat conduction problems.

UNIT II - PROBABILITY (9 hours)

basic definition, conditional, Probability, Baye's theorem - Binomial, Poisson, Normal, Exponential, Rectangular, Gamma Distributions. Moment generating function, random variables, two dimensional random variables.

UNIT III - PRINCIPLE OF LEAST SQUARES (9 hours)

Fitting of Straight line and parabola - Correlation - Linear multiple and partial correlation - Linear regression - Multiple regression.

UNIT IV - SAMPLING DISTRIBUTIONS (9 hours)

Tests based on t-distribution, chi-square and F-distributions - Analysis of variance - One-way and two-way classifications.

UNIT V - TIME SERIES ANALYSIS (9 hours)

Significance of time series analysis - Components of Time series - Secular trend - Graphical method - Semi-average method - Method of Moving Averages - Method of Least squares - Seasonal variations - Method of Simple Averages - Ratio to trend method - Ratio to moving average method.

REFERENCES

1. Sankara Rao K, "*Introduction to Partial Differential Equations*", PHI, New Delhi, 2003
2. Gupta S.C. and Kapoor V.K., "*Fundamentals of Mathematical Statistics*", Sultan Chand and Sons, New Delhi, 1999
3. Kapoor V.K., "*Statistics (Problems and Solutions)*", Sultan Chand and Sons", New Delhi 1994
4. Montgomery D.C. and Johnson L.A., "*Forecasting and Time Series*", McGraw Hill
5. Anderson O.D., "*Time Series Analysis: Theory and Practice*", I. North-Holland, Amsterdam, 1982.

MA2007	APPLIED MATHEMATICS FOR MECHANICAL ENGINEERS	L	T	P	C
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Total contact hours - 45	3	0	0	3
Prerequisite				
Nil				

PURPOSE

To develop analytical capability and to impart knowledge in Mathematical and Statistical methods and their applications in Engineering and Technology and to apply these concepts in engineering problems they would come across.

INSTRUCTIONAL OBJECTIVES

At the end of the course, Students should be able to understand Mathematical and Statistical concepts and apply the concepts in solving the engineering problems.

UNIT I - TRANSFORM METHODS

(9 hours)

Laplace transform methods for one-dimensional wave equation - Displacements in a string - Longitudinal vibrations of an elastic bar - Fourier transform methods for one-dimensional heat conduction problems in infinite and semi-infinite rod.

UNIT II - ELLIPTIC EQUATIONS

(9 hours)

Laplace equation - Fourier transform methods for Laplace equation - Solution of Poisson equation by Fourier transform method.

UNIT III - CALCULUS OF VARIATIONS

(9 hours)

Variation and its properties - Euler's equation - Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables - Some applications - Direct methods - Ritz methods.

UNIT IV - NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

(9 hours)

Numerical Solution of Partial Differential Equations - Solution of Laplace's and Poisson equation on a rectangular region by Liebmann's method - Diffusion equation by the explicit and Crank Nicholson implicit methods - Solution of wave equation by explicit scheme.

UNIT V - REGRESSION METHODS

(9 hours)

Principle of least squares - Correlation - Multiple and Partial correlation - Linear and non-linear regression - Multiple linear regression.

REFERENCES

1. Sankara Rao K., "Introduction to Partial Differential Equations", 4th printing, PHI, New Delhi, April 2003
2. Elsgolts L., "Differential Equations and Calculus of Variations", Mir Publishers, Moscow, 1966

3. S.S. Sastry, "Introductory Methods of Numerical Analysis", 3rd Edition, PHI, 2001
4. Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, Reprint 2003

ME2291	GLOBAL OPTIMIZATION ALGORITHMS	L	T	P	C
	Total contact hours - 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To study the principles of optimization and various techniques which can be used for solving Mechanical Engineering optimization applications.					
INSTRUCTIONAL OBJECTIVES					
To study the following optimization techniques					
1.	Evolutionary Algorithms				
2.	Genetic Algorithms				
3.	Modern optimization techniques				
4.	Search Algorithms				

UNIT I - INTRODUCTION TO OPTIMIZATION ALGORITHMS (9 hours)

Introduction - A Classification of Optimization Algorithms- an optimum- The Structure of Optimization - Formae and Search Space/Operator Design.

Evolutionary Algorithms – Introduction - The Basic Principles from Nature - The Basic Cycle of Evolutionary Algorithms - The Basic Evolutionary Algorithm Scheme - Classification of Evolutionary Algorithms - Configuration Parameters of evolutionary algorithms - Fitness Assignment - Tournament Selection - Ranking Selection - VEGA Selection - Simple Convergence Prevention.

UNIT II - GENETIC ALGORITHMS AND GENETIC PROGRAMMING (9 hours)

Genetic Algorithms - Areas of Application – Genomes - Fixed-Length String Chromosomes - Variable-Length String Chromosomes - Schema Theorem - The Messy Genetic Algorithm - Genotype-Phenotype Mappings and Artificial Embryogeny Genetic Programming- Tree Genomes- Genotype-Phenotype Mappings - Grammars in Genetic Programming - Linear Genetic Programming - Artificial Life and Artificial Chemistry- Correctness of the Evolved Algorithms

UNIT III - MODERN OPTIMIZATION TECHNIQUES (9 hours)

Ant Colony Optimization- Areas of Application - River Formation Dynamics
Particle Swarm Optimization - Areas of Application

Hill Climbing - Areas of Application - Multi-Objective Hill Climbing - Problems in Hill Climbing - Hill Climbing with Random Restarts – GRASP - Raindrop Method, Random Optimization

UNIT IV - MODERN OPTIMIZATION TECHNIQUES (9 hours)

Simulated Annealing- Temperature Scheduling- Multi-Objective Simulated Annealing, Extremal Optimization, Tabu Search, Memetic and Hybrid Algorithms, Downhill Simplex (Nelder and Mead)

UNIT V - SEARCH ALGORITHMS (9 hours)

State Space Search - Uninformed Search - Breadth-First Search - Depth-First Search - Depth-limited Search - Iterative Deepening Depth-First Search - Random Walks Informed Search - Greedy Search- A* search - Adaptive Walks

REFERENCES

1. Thomas Weise, "Global Optimization Algorithms – Theory and Application", Thomas Weise, 2009, <http://www.it-weise.de/>
2. Rao, S.S., "Optimization – Theory and Applications", Wiley Eastern, New Delhi, 2009
3. Hans Paul Schwefel., "Evolution and Optimum Seeking", Wiley-Interscience, 1995.

MECHATRONICS IN MANUFACTURING SYSTEMS		L	T	P	C
ME2292	Total contact hours – 45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

To provide elements of mechatronics in manufacturing systems

INSTRUCTIONAL OBJECTIVES

To familiarize

- | | |
|----|---|
| 1. | Combined knowledge of mechanical, electronics and information systems |
| 2. | Sensors and actuation systems |
| 3. | Microprocessor systems |
| 4. | Electrical ladder diagrams and PLC applications |
| 5. | Mechatronics applications and case study |

UNIT I - SENSORS AND ACTUATORS (9 hours)

Introduction to Mechatronics systems- measurement systems, sequential controllers & electric position sensors- limit switches- photoelectric sensors- proximity sensors-

Inductive, capacitive, Magnetic sensors, pneumatic limit valve - electric actuators- Linear solenoids-linear induction motors-Rotary- stepper motors.

UNIT II - MICROPROCESSORS IN MECHATRONICS (10 hours)

The microprocessor systems (8085) – Architecture- Input and output peripheral circuits, the development of microprocessor systems-communications, A/D and D/A converters.

UNIT III - RELAYS AND ELECTRIC LADDER DIAGRAM (9hours)

Relays- electromechanical-solid state –ladder diagrams-sequence charts- Ladder diagram design – using sequence charts through cascade method-single path sequencing with and without sustained outputs- multi path sequencing systems- designing of ladder diagram for specific applications.

UNIT IV - PLC PROGRAMMING (9 hours)

Programmable Logic controllers(PLC)- construction and basic structure- programming units-Memory – input output modules-mnemonics – Timers – internal relays-counters –shift registers-Master and jump control and Data handling- analog input/ output – programming the PLC using ladder diagrams – simple examples of PLC applications- selection of PLC.

UNIT V - MECHATRONICS APPLICATIONS AND CASE STUDY (8 hours)

Time delay using PLC- Time delay using intel 555, Wind screen wiper using stepper motor control, Electronic washing machine.

CASE STUDIES

Pick and Place Robot – automatic camera- car engine management- bar code reader

REFERENCES

1. Bolton.W., "*Mechatronics*", Addison- Wesley, 2nd edition,1999.
2. Michael.B.B. Histan, "*Introduction to Mechatronics and measurement systems*", McGraw-Hill International Edition, 1999.
3. Goankar.R.S., "*Microprocessor Architecture Programming and Applications*", Wiley Eastern, 1997.
4. Rohner P. "*Automation with programmable logic controllers*", Macmillan, 1996.
5. Chrionis. N, "*Mechanics, Linkages and Mechanical controls*", McGraw Hill,1996
6. Brian Morris, "*Automatic Manufacturing Systems Actuators, Controls & Sensors*", McGraw Hill,1994
7. David. W. Pessen., "*Industrial Automation Circuit Design and components*", John Wiley & Sons,1990.

OTHER COURSES

ME2296	Seminar	L	T	P	C
	Prerequisite	0	0	1	1
	Nil				

Students have to present a minimum of three seminar papers on the topics of current interest. The evaluation will be based on the knowledge of the student on the subject of presentation, their communication abilities, the method of presentation, the way questions were answered and his attention to the other students' seminars.

ME2297	Project Work – Phase I	L	T	P	C
	Prerequisite	0	0	12	6
	Nil				

Students can register for this course only after earning at least 12 credits in the core courses of their study.

ME2298	Project Work – Phase II	L	T	P	C
	Prerequisite	0	0	32	16
	Project – Phase I				

Students can register for this course only after earning at least 16 credits in the core courses of their study.

Students can enroll for this course only after completing Project Work-Phase I.

SEMESTER I

CAC2001	Career Advancement Course For Engineers - I	L	T	P	C
	Total Contact Hours - 30	1	0	1	1
	Prerequisite				
	Nil				

PURPOSE
To enhance holistic development of students and improve their employability skills

INSTRUCTIONAL OBJECTIVES

1. To improve aptitude, problem solving skills and reasoning ability of the student.
2. To collectively solve problems in teams & group.
3. Understand the importance of verbal and written communication in the workplace
4. Understand the significance of oral presentations, and when they may be used.
5. Practice verbal communication by making a technical presentation to the class
6. Develop time management Skills

UNIT I–BASIC NUMERACY

- Types and Properties of Numbers, LCM, GCD, Fractions and decimals, Surds

UNIT II-ARITHMETIC – I

- Percentages, Profit & Loss, Equations

UNIT III-REASONING - I

- Logical Reasoning

UNIT IV-SOFT SKILLS - I

- Presentation skills, E-mail Etiquette

UNIT V-SOFT SKILLS - II

- Goal Setting and Prioritizing

ASSESSMENT

Soft Skills (Internal)

Assessment of presentation and writing skills.

Quantitative Aptitude (External)

Objective Questions- 60 marks

Descriptive case lets- 40 marks*

Duration: 3 hours

*Engineering problems will be given as descriptive case lets.

REFERENCE:

1. Quantitative Aptitude by Dinesh Khattar – Pearsons Publicaitons
2. Quantitative Aptitude and Reasoning by RV Praveen – EEE Publications
3. Quantitative Aptitude by Abijith Guha – TATA Mc GRAW Hill Publications
4. Soft Skills for Everyone by Jeff Butterfield – Cengage Learning India Private Limited
5. Six Thinking Hats is a book by [Edward de Bono](#) - Little Brown and Company
6. IBPS PO - CWE Success Master by Arihant - Arihant Publications(I) Pvt.Ltd – Meerut

SEMESTER II

CAC2002	Career Advancement Course For Engineers - II	L	T	P	C
	Total Contact Hours - 30	1	0	1	1
	Prerequisite				
	Nil				

PURPOSE
To enhance holistic development of students and improve their employability skills

INSTRUCTIONAL OBJECTIVES

1. To improve aptitude, problem solving skills and reasoning ability of the student.
2. To collectively solve problems in teams & group.
3. Understand the importance of verbal communication in the workplace
4. Understand the significance of oral presentations, and when they may be used.
5. Understand the fundamentals of listening and how one can present in a group discussion
6. Prepare or update resume according to the tips presented in class.

UNIT I-ARITHMETIC – II

- Ratios & Proportions, Mixtures & Solutions

UNIT II - MODERN MATHEMATICS

- Sets & Functions, Data Interpretation, Data Sufficiency

UNIT III – REASONING - II

- Analytical Reasoning

UNIT IV – COMMUNICATION - I

- Group discussion, Personal interview

UNIT V - COMMUNICATION - II

- Verbal Reasoning test papers

ASSESSMENT

Communication (Internal)

- Individuals are put through formal GD and personal interviews.
- Comprehensive assessment of individuals' performance in GD & PI will be carried out.

Quantitative Aptitude (External)

Objective Questions- 60 marks (30 Verbal +30 Quants)

Descriptive case lets- 40 marks*

Duration: 3 hours

*Engineering problems will be given as descriptive case lets.

REFERENCES

1. Quantitative Aptitude by Dinesh Khattar – Pearsons Publicaitons
2. Quantitative Aptitude and Reasoning by RV Praveen – EEE Publications
3. Quantitative Aptitude by Abijith Guha – TATA Mc GRAW Hill Publications
4. General English for Competitive Examination by A.P. Bharadwaj – Pearson Educaiton
5. English for Competitive Examination by Showick Thorpe - Pearson Educaiton
6. IBPS PO - CWE Success Master by Arihant - Arihant Publications(I) Pvt.Ltd - Meerut
7. Verbal Ability for CAT by Sujith Kumar - Pearson India
8. Verbal Ability & Reading Comprehension by Arun Sharma - Tata McGraw - Hill Education

SEMESTER III

CAC2003	Career Advancement Course For Engineers - III	L	T	P	C
	Total Contact Hours - 30	1	0	1	1
	Prerequisite				
	Nil				
PURPOSE					
To develop professional skills abreast with contemporary teaching learning methodologies					
INSTRUCTIONAL OBJECTIVES					
At the end of the course the student will be able to					
1	acquire knowledge on planning, preparing and designing a learning program				
2	prepare effective learning resources for active practice sessions				
3	facilitate active learning with new methodologies and approaches				
4	create balanced assessment tools				
5	hone teaching skills for further enrichment				

UNIT I- DESIGN

(2 hrs)

- Planning & Preparing a learning program.
- Planning & Preparing a learning session

UNIT II – PRACTICE

(2 hrs)

- Facilitating active learning
- Engaging learners

UNIT III – ASSESSMENT

(2 hrs)

- Assessing learner’s progress
- Assessing learner’s achievement

UNIT IV – HANDS ON TRAINING

(10 hrs)

- Group activities – designing learning session
- Designing teaching learning resources
- Designing assessment tools
- Mock teaching session

UNIT V – TEACHING IN ACTION

(14 hrs)

- Live teaching sessions
- Assessments

ASSESSMENT (Internal)

Weightage:

Design - 40%

Practice – 40%

Quiz – 10%

Assessment – 10%

REFERENCES

Cambridge International Diploma for Teachers and Trainers Text book by Ian Barker - Foundation books

Whitehead, Creating a Living Educational Theory from Questions of the kind: How do I improve my Practice? Cambridge J. of Education