SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

M.Tech. (Full Time) - Robotics
Curriculum & Syllabus
2015 – 2016

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

M.Tech Robotics
Curriculum 2015 – 2016
For students admitted from the academic year 2015 – 2016
Course Mapping

Category	Number 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 or II or III semester			
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				

Core courses					
COURSE CODE	COURSE NAME	L	T	P	C
ME2301	Fundamentals of Robotic systems	3	0	2	4
ME2302	Micro controller and its application in robotics	3	0	2	4
ME2303	Drives and Control Systems for Robots	3	0	2	4
ME2304	Computer Aided Design and Manufacturing	3	0	2	4
ME2305	Kinematics and Dynamics of Robots	3	0	2	4
ME2306	Robot Programming	3	0	2	4
Optional / Elective Courses (Program Electives)					
COURSE CODE	COURSE NAME	L	T	P	C
ME2113	Advanced Strength of materials	3	0	0	3
ME2118	Neural Networks, GAs and its Applications	3	0	0	3
ME2122	Rapid Prototyping and Tooling	3	0	0	3
ME2191	Visual Programming and its applications	3	0	0	3
ME2218	Group Technology and Cellular Manufacturing	3	0	0	3
ME2291	Global optimization algorithms	3	0	0	3
ME2216	Design of experiments	3	0	0	3
ME2311	Robot Vision	3	0	0	3

ME2312	Robotic Simulation	3	0	0	3
ME2313	Robotic Sensors	3	0	0	3
ME2314	Fundamentals of Artificial Intelligence for Robotics	3	0	0	3
ME2315	Modern Material Handling Systems	3	0	0	3
ME2316	Robot Economics	3	0	0	3
ME2317	Computer Integrated Design	3	0	0	3
ME2318	Manufacturing System Simulation	3	0	0	3
ME2319	CNC Machining Technology	3	0	0	3
ME2320	Finite Element Analysis	3	0	0	3
ME2321	Principles of Computer Integrated Manufacturing systems	3	0	0	3
ME2322	Nano robotics	3	0	0	3
ME2323	Computer Graphics	3	0	0	3
ME2324	Optimization in Engineering Design	3	0	0	3
Supportive courses					
COURSE CODE	COURSE NAME	L	T	P	C
MA2006 / MA2007	Computational Methods in Engineering /Applied Mathematics for Mechanical Engineers	3	0	0	3
		3	0	0	3
ME2391	Mobile robot	3	0	0	3
Other Courses					
ME2396	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
ME2397	Project work Phase I	0	0	12	6
ME2398	Project work Phase II	3	0	32	16

CONTACT HOUR/CREDIT:

L: Lecture Hours per week T: Tutorial Hours per week

P: Practical Hours per week C: Credit

ME2301	FUNDAMENTALS OF ROBOTIC SYSTEMS	L	T	P	C
	Total Contact Hours-75	3	0	2	4
	Prerequisites				
	Nil				

PURPOSE	
To enlighten the students about the fundamentals of robotic systems.	
INSTRUCTIONAL OBJECTIVES	
At the end of this course the student should be able to understand	
1.	The basics of robot
2.	End effectors and robot controls
3.	Robot Transformations and Sensors
4.	Robot cell design and applications
5.	Micro/Nano robotic systems

UNIT I - INTRODUCTION (9 hours)

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems-Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems-Hydraulic, Pneumatic and Electric system.

UNIT II - END EFFECTORS AND ROBOT CONTROLS (10 hours)

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

UNIT III - ROBOT TRANSFORMATIONS AND SENSORS (8 hours)

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation-Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.

UNIT IV - ROBOT CELL DESIGN AND APPLICATIONS (9 hours)

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot.

UNIT V - MICRO/NANO ROBOTICS SYSTEM (9 hours)

Micro/Nanorobotics system overview-Scaling effect-Top down and bottom up approach- Actuators of Micro/Nano robotics system-Nanorobot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nanorobot in targeted drug delivery system.

PRACTICAL (30 hours)

REFERENCES

1. Deb .S.R, "*Robotics Technology and flexible automation"*, Tata McGraw-Hill Education, 2009.
2. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, *"Technology Programming and Applications"*, McGraw Hill, 2012.
3. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "*Robotics Engineering an Integrated Approach"*, Phi Learning., 2009.
4. Francis N. Nagy, Andras Siegler, "*Engineering Foundation of Robotics"*, Prentice Hall Inc., 1987.
5. Janaki Raman .P.A, "*Robotics and Image Processing an Introduction"*, Tata McGraw Hill Publishing company Ltd., 1995.
6. Carl D. Crane and Joseph Duffy, "*Kinematic Analysis of Robot manipulators"*, Cambridge University Press, 2008.
7. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "*Robotics Control, Sensing, Vision and Intelligence"*, McGraw Hill Book co, 1987.
8. Craig. J. J. "*Introduction to Robotics Mechanics and Control"*, Addison- Wesley, 1999.
9. Ray Asfahl. C., "*Robots and Manufacturing Automation"*, John Wiley & Sons Inc.,1985.
10. Bharat Bhushan., "*Springer Handbook of Nanotechnology"*, Springer, 2004.
11. Julian W. Gardner., "*Micro sensor MEMS and Smart Devices"*, John Wiley & Sons, 2001.

	MICROCONTROLLER AND ITS APPLICATION IN ROBOTICS	L	T	P	C
ME2302	Total Contact Hours-75	3	0	2	4
	Prerequisites				
	Nil				
PURPOSE					
To familiarize the students with the fundamentals of microcontroller based system design.					
INSTRUCTIONAL OBJECTIVES					
Upon successful completion of the course the students will be able to understand and apply					

1.	8051 Microcontroller based system.
2.	Programming of microcontroller in real time applications
3.	Communication with external devices
4.	Basics of PIC microcontroller

UNIT I - INTRODUCTION TO 8051 MICROCONTROLLER (9 hours)

Data representation- decimal system, binary system, hexadecimal system. Binary to decimal conversion, decimal to Hexadecimal, binary addition and subtraction, MCS51 Micro controller: internal architecture, pin description, addressing modes. Difference between microcontroller and microprocessor, criteria for choosing a microcontroller

UNIT II - 8051 PROGRAMMING (9 hours)

Instruction set-arithmetic, logical, data transfer, branching and Flag manipulation Instructions. 8051 assembly language programming- Timers, Interrupts, I/O ports, Interfacing I/O Devices, Serial Communication, Introduction to C programming in 8051,introduction to RTOS.

UNIT III - PERIPHERAL INTERFACING (9 hours)

Real world interfacing- Analog to Digital converter, Digital to Analog converter, Mechanical switches, LEDs, seven segment display, keypads, LCDs, DC motor, stepper motor, PWM, External Memory Interface.

UNIT IV - PIC MICROCONTROLLER (9 hours)

Architecture, memory organization - addressing modes. Instruction set - PIC programming in Assembly & C- I/O port, Data Conversion, RAM & ROM allocation, Timer programming. Interfacing concepts - I^2C, SSP bus operations

UNIT V - MICROCONTROLLER IN ROBOTICS (9 hours)

Case Studies –Home security system, Tic tac toe, Micro-mouse, Soccer playing robot, Unmanned Ariel vehicles, Smart card application

PRACTICAL (30 hours)

REFERENCES
1. Mazidi, "*The 8051 Microcontroller and Embedded System*", Pearson education , 2002.
2. Han-way Huang, "*Using the MCS-51 Microcontroller*", Oxford University Press, 2009.
3. John B. Peatman, "*Design with PIC Microcontroller"*, McGraw Hill International Ltd., 1997.
4. Scott Mackenzie, Raphael C. W. Phan, "*The 8051 Microcontroller*", Prentice Hall, 2007.
5. Muhammed Ali Mazidi, "*The 8051 Microcontroller and Embedded systems*", Prentice Hall, 2000.
6. Uma Rao .K, Andhe Pallavi, *"The 8051 Microcontroller Architecture, Programming and Applications"* ,Pearson Education India, 2010.
7. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, "*PIC Microcontroller and Embedded Systems"*, Pearson Education, 2007.

	DRIVES AND CONTROL SYSTEMS FOR ROBOTS	L	T	P	C
ME2303	Total Contact Hours-75	3	0	2	4
	Prerequisites				
	Nil				

PURPOSE

To impart knowledge about various drive systems and its selection for particular applications.

INSTRUCTIONAL OBJECTIVES

At the end of this course the student should be able to understand

1.	Various types of drive systems.
2.	The selection of drive system for a particular application.
3.	Accurate positioning of the robot end effectors with error compensation by servo control.

UNIT I - ROBOT DRIVE MECHANISM (8 hours)

Objectives, motivation, open loop control, closed loop control with velocity and position feedback, Types of drive systems. Functions of drive system.

Lead Screws, Ball Screws, Chain & linkage drives, Belt drives, Gear drives, Precision gear boxes, Harmonic drives, Cyclo speed reducers.

UNIT II - HYDRAULIC DRIVES (8 hours)

Introduction, Requirements, Hydraulic piston and transfer valve, hydraulic circuit incorporating control amplifier, hydraulic fluid considerations, hydraulic actuators Rotary and linear actuators. Hydraulic components in robots.

UNIT III - PNEUMATIC DRIVES (8 hours)

Introduction, Advantages, pistons-Linear Pistons, Rotary pistons, Motors-Flapper motor, Geared motor, Components used in pneumatic control. Pneumatic proportional controller, pneumatically controlled prismatic joint.

UNIT IV - ELECTRIC DRIVES (9 hours)

Introduction, Types, DC electric motor, AC electric motor, stepper motors, half step mode operation, micro step mode. Types of stepper motors, Direct drive actuator.

UNIT V - SERVO SYSTEMS FOR ROBOT CONTROL (12 hours)

General aspects of robot control. Basic control techniques, mathematical modeling of robot servos, error responses and steady state errors in robot servos, feed back and feed forward compensations, hydraulic position servo, computer controlled servo system for robot applications, selection of robot drive systems.

PRACTICAL (30 hours)

REFERENCES

1. Francis N-Nagy Andras Siegler, "*Engineering Foundation of Robotics"*, Prentice Hall Inc., 1987.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "*Robotics Engineering an Integrated Approach"*, Phi Learning., 2009.
3. Janaki Raman P.A., "*Robotics and Image Processing an Introduction"*, Tata Mc Graw Hill Publishing company Ltd., 1995.
4. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, *"Industrial Robotics, Technology programming and Applications*", Tata McGraw-Hill Education, 2012.
5. Bernard Hodges, *"Industrial Robotics*", Second Edition, Jaico Publishing house, 1993.
6. Robert J. Schilling, "*Fundamentals of Robotics Analysis and Control"*, PHI Learning., 2009.
7. Tsuneo Yohikwa, *"Foundations of Robotics Analysis and Control*", MIT Press., 2003.
8. John J. Craig, *"Introduction to Robotics Mechanics and Control*", Third Edition, Pearson, 2008.

ME2304	COMPUTER AIDED DESIGN AND MANUFACTURING	L	T	P	C
	Total Contact Hours-75	3	0	2	4
	Prerequisites				
	Nil				

PURPOSE	
To study CAD/CAM applications in the field of Mechanical Engineering.	
INSTRUCTIONAL OBJECTIVES	
At the end of this course the student should be able to understand	
1.	The basics of CAD modeling
2.	Numerical control machine operation and automation
3.	Concepts of GT, FMS, AGV's, AS / RS systems
4.	Various planning systems and process monitoring

UNIT I - GEOMETRIC MODELLING (9 hours)

Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves hermite cubic splines Bezier curves B-splines rational curves.

UNIT II - SURFACE MODELING (9 hours)

Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.

SOLID MODELLING-3D

Solid modeling, Solid Representation, Boundary Representation (Brep), Constructive Solid Geometry (CSG)

UNIT III - AUTOMATION AND NUMERICAL CONTROL (9 hours)

Automation – Definition. Type, Strategies – NC Systems –Types, Coordinate systems, Interpolation schemes – NC part programming – Manual, Computer assisted part programming – APT Languages – DNC – CNC –Adaptive control.

UNIT IV - GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS (9 hours)

Part families – Part classification and coding systems – production flow analysis – Machine cell design – Benefits of GT –FMS- Concept, workstation, Layout, Analysis method, Benefits – Material handling systems – Types – Conveyor systems – AGV'S – AS/RS system – Analysis method.

UNIT V - MANUFACTURING PLANNING SYSTEMS AND PROCESS CONTROL (9 hours)

CAPP - Computer Integrated production planning systems –MRP – Capacity planning – Shop Floor control factory Data collection systems – Computer process interface types of computer process control – process monitoring, Supervisory computer control.

PRACTICAL (30 hours)

REFERENCES

1. Mikell P.Groover, "*Automation Production Systems and Computer – Integrated Manufacturing*", Prentice Hall of India. Ltd., 1998.
2. Ibrhim Zeid, "*Mastering CAD/CAM*", McGraw Hill international, 2005.
3. Rao P.N., "*CAD/CAM: Principles and Applications*", Tata McGraw Hill, 2010.
4. Deb .S.R, "*Robotic Technology and Flexible automation*".
5. Narang .J.S & Sherawat .M.S, "*CNC Machines*" Dhanpaty Rai & Co, 1999.
6. Rao .P.N, Tewari .N.K & Kundra .T.K, "*Computer Aided Manufacturing*", Tata McGraw Hill, 2001.
7. Groover .M.P & Zimmers .W, "*CAD/CAM*" Prentice Hall 1990.
8. Yoram Koren, "*Computer Integrated Manufacturing Systems",* McGraw Hill, 1983.
9. Paul G. Ranky, "*Computer Integrated Manufacturing*", Prentice Hall, 1990.
10. David Bedworth, "*Computer Integrated Design & Manufacturing*", TMH, New Delhi, 1998.
11. Kant Vajpayee .S, *"Principles of CIM*" Prentice Hall of India, 1995.

ME2305	KINEMATICS AND DYNAMICS OF ROBOTS	L	T	P	C
	Total Contact Hours-75	3	0	2	4
	Prerequisites				
	Nil				

PURPOSE	
To impart knowledge about kinematic and dynamic analysis of robot manipulators.	
INSTRUCTIONAL OBJECTIVES	
To Learn	
1.	To control both the position and orientation of the tool in the three dimensional space.
2.	The relationship between the joint variables and the position and the orientation of the tool.
3.	Planning trajectories for the tool to follow on order to perform meaningful tasks.
4.	To precisely control the high speed motion of the system.

UNIT I - INTRODUCTION (9 hours)

Introduction, position and orientation of objects, objects coordinate frame Rotation matrix, Euler angles Roll, pitch and yaw angles coordinate Transformations, Joint

variables and position of end effector, Dot and cross products, coordinate frames, Rotations, Homogeneous coordinates.

UNIT II - DIRECT KINEMATICS (8 hours)

Link coordinates D-H Representation, The ARM equation. Direct kinematic analysis for Four axis, SCARA Robot and three, five and six axis Articulated Robots.

UNIT III - INVERSE KINEMATICS (9 hours)

The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis, Articulated robot.

UNIT IV - WORKSPACE ANALYSIS AND TRACJECTORY PLANNING (9 hours)

Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning.

UNIT V - MANIPULATOR DYNAMICS (10 hours)

Introduction, Lagrange's equation kinetic and potential energy. Link inertia Tensor, link Jacobian Manipulator inertia tensor. Gravity, Generalized forces, Lagrange-Euler Dynamic model, Dynamic model of a Two-axis planar robot, Newton Euler formulation, Lagrange - Euler formulation, problems.

PRACTICAL (30 hours)

REFERENCES

1. Robert J. Schilling, "*Fundamentals of Robotics Analysis and Control*", PHI Learning., 2009.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "*Robotics Engineering an Integrated Approach*", Phi Learning., 2009.
3. Janaki Raman .P.A, "*Robotics and Image Processing An Introduction*", Tata Mc Graw Hill Publishing company Ltd., 1995.
4. Francis N-Nagy Andras Siegler, "*Engineering foundation of Robotics*", Prentice Hall Inc., 1987.
5. Bernard Hodges, "*Industrial Robotics*", Second Edition, Jaico Publishing house, 1993.
6. Tsuneo Yohikwa, "*Foundations of Robotics Analysis and Control*", MIT Press., 2003.
7. John J. Craig, "*Introduction to Robotics Mechanics and Control*", Third Edition, Pearson, 2008.
8. Bijay K. Ghosh, Ning Xi, T.J. Tarn, "*Control in Robtics and Automation Sensor – Based integration*", Academic Press, 1999.

ME2306	ROBOT PROGRAMMING	L	T	P	C
	Total Contact Hours-75	3	0	2	4
	Prerequisites				
	Nil				

PURPOSE	
To enlighten the students about the use of robot programming for various applications.	
INSTRUCTIONAL OBJECTIVES	
At the end of this course the student should be able to understand the	
1.	Basics of Robot programming
2.	VAL language applications
3.	RAPID language applications
4.	Practical study of virtual robot software
5.	VAL-II and AML language

UNIT I - BASICS OF ROBOT PROGRAMMING (10 hours)

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands-Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.

UNIT II - VAL LANGUAGE (9 hours)

Robot Languages-Classifications, Structures- VAL language commands- motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications.

UNIT III - RAPID LANGUAGE (9 hours)

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command based programming. Movemaster command language-Introduction, syntax, simple problems.

UNIT IV - PRACTICAL STUDY OF VIRTUAL ROBOT (9 hours)

Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software-Introduction, Jogging, components, work planning, program modules, input and output signals-Singularities-Collision detection-Repeatability measurement of robot-Robot economics.

UNIT V - VAL-II AND AML (8 hours)

VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements- Operating systems, Motion, Sensor commands-Data processing.

PRACTICAL (30 hours)

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. Robotics Lab manual, 2007.
7. www.wpi.edu

ELECTIVE COURSES

		L	T	P	C
ME2113	ADVANCED STRENGTH OF MATERIALS	3	0	0	3
	Total Contact Hours - 45				
	Prerequisites				
	Nil				
PURPOSE					
To familiarize the students in the areas of stress, strain and deformation for 3D problems					
INSTRUCTIONAL OBJECTIVES					
Upon successful completion of the course the students will be able to solve practical problems involving Unsymmetrical bending, stress in flat plates, Torsion of noncircular sections and contact stresses					

UNIT I-INTRODUCTION (9 hours)

Stress-strain relations and general equations of elasticity in Cartesian, polar and spherical co-ordinates equations of equilibrium - compatibility - boundary conditions - representation of 3-dimentinal stress -tensor - generalized Hooke's law - St.Venant's principle - plane strain - plane stress - Airy's stress function

UNIT II- UN-SYMMETRICAL BENDING (9 hours) – (review of symmetrical bending will be done before starting with unsymmetrical bending)

Stress and deflections in beams subjected to unsymmetrical loading - kern of a section

UNIT III –SHEAR CENTER, CURVED FLEXURAL MEMBERS (9 hours) – (review of determination of transverse shear stress will be done before starting with location of shear center)

SHEAR CENTRE - Location of shear center for various sections - shear flow. CURVED FLEXURAL MEMBERS - circumferential and radial stresses - deflections - curved beam with restrained ends - closed ring subjected to concentrated loading and uniform load - chain links and crane hooks

UNIT IV-STRESS IN FLAT PLATES (9 hours)

Stresses in circular and rectangular plates due to various types of loading and end conditions - buckling of plates.

UNIT V-TORSION, STRESSES DUE TO ROTATION, CONTACT STRESSES (9 hours)

Torsion of rectangular cross section - St. Venant's theory - elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin-walled tubes - STREES

DUE TO ROTATION - Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness – allowable speeds. Methods of computing contact stresses - deflection of bodies in points and line contact - applications.

REFERENCES

1. Seely and Smith, "*Advanced mechanics of materials*", John Wiley International Edn, 1952.
2. Rimoahwnko, "*Strength of Materials*", Van Nostrand., 1970
3. Den Hartong, "*Advanced Strength of Materials*", McGraw Hill Book Co., New York 1952.
4. Timoshenko and Goodier, "*Theory of Elasticity*", McGraw Hill., 1994
5. Wang, "*Applied Elasticity*", McGraw Hill., 1979
6. Case, "*Strength of Materials*", Edward Arnold, London 1957.
7. Robert D. Cook, Warren C. Young, "*Advanced Mechanics of Materials*", Macmillian Pub. Co. 1952
8. Durelli, Phillips and Tso, "*Introduction to the Theoretical and Experimental Analysis of stress and strain*", McGraw Hill, 1958

	NEURAL NETWORKS, GAs AND ITS APPLICATIONS	L	T	P	C
ME2118	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				

PURPOSE	
To study about the modern tools Neural Networks and Genetic algorithms and its applications to Mechanical Engineering.	
INSTRUCTIONAL OBJECTIVES	
1.	Basic concepts of Genetic Algorithms
2.	Application of GAs to Mechanical Engineering
3.	Advances in Genetic Algorithms
4.	Basic concepts of Neural Networks and applications of GAs to Neural networks
5.	Applications of GAs and Neural networks to Mechanical Engineering

UNIT I - INTRODUCTION AND CONCEPT OF GENETIC ALGORITHMS (9 hours)
GAs - Robustness of Traditional Optimization Techniques - Distinctiveness of GAs from Traditional Optimization producers - Mathematical foundation of GAs Similarity Templates - Working of Schema Process - Minimal Deceptive Problem - Similarity Templates as Hyper planes.

UNIT II - IMPLEMENTATION OF GAs AND ADVANCED TECHNIQUES IN GENETIC SEARCH (9 hours)

Data Structures - Reproduction , Crossover and Mutation - Mapping objective functions to Fitness From - Fitness Scaling - Multiparameter , Mapped , Fixed Point Coding - Computer Implementation - Evolution of Dominance , Diploidy and Abeyance - Inversion and other reordering operators - Multi objective optimization - Knowledge based Techniques - GAs and Parallel Processors.

UNIT III - GENETIC BASED MACHINE LEARNING (9 hours)

Classifier System - Rule and Message System - Results using Classifier System - The Rise of GBML -Development of Cognitive System - CS-1in operation - Performance of CS- 1 and LS - 1 - Other GBML efforts - Computer Assignments.

UNIT IV - NEURAL NETWORKS AND APPLICATION OF GAs TO NEURAL NETWORKS (9 hours)

Fundamentals of Neural Networks - Biological Basis - Features of Artificial Neural Networks - Back Propagation Training - Modular Neural Networks - Fitness Function - Application of GAs to Neural Networks - Use of Genetic Algorithms to Neural Networks - Use of Genetic Algorithms in the Design of Neural Networks.

UNIT V - APPLICATIONS (9 hours)

GAs applications in Pattern Recognition - Function Optimization - Improvements in Basic Technique - Optimization of Pipeline System - Multi model and Multi objective Optimization - Nonlinear Optimization.

REFERENCES

1. Zbigniew Michlewicz, "*Genetic Algorithms + Data Structures = Evolution Programs*", Springer - Verlag , 1994.
2. Lefteri H. Tsoukalas and Robert E. Uhrig , "*Fuzzy and Neural Approaches in Engineering"*, John Wiley & Sons, Inc , 1997.
3. Freeman J. A., and skapura D. M., "*Neural Networks: Algorithms, Applications and Programming Techniques*", Addison Wealaff, 1990.
4. Leurene Fausett, "*Fundamentals of Neural Networks: Architectures, Algorithms and Applications"*, Prentice Hall, 1994.

ME2122	RAPID PROTOTYPING AND TOOLING	L	T	P	C
	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 (9 hours)

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 (9 hours)

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 (9 hours)

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

UNIT IV - RAPID TOOLING (9 hours)

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

UNIT V - REVERSE ENGINEERING (9 hours)

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 all, "*Rapid Tooling*", Marcel, Dekker 2000.
4. Beaman .J.J et all, "*Solid freeform fabrication*", Kluwer, 1997.
5. Jacohs 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.

	VISUAL PROGRAMMING AND ITS APPLICATIONS	L	T	P	C
ME2191	Total Contact Hours-45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To study the general purpose programming tools Visual Basic and Visual C++.					
INSTRUCTIONAL OBJECTIVES					
1.	Various programming methodologies				
2.	Microsoft Windows and its programming methods				
3.	Writing and debugging programs using Visual Basic				
4.	Writing and debugging programs using Visual C++				
5.	Solving programs applied to Mechanical Engineering				

UNIT I - HISTORICAL DEVELOPMENT OF PROGRAMMING (9 hours)
Procedural programming – Structural programming – object oriented programming – windows programming- event driven programming – conceptual comparison.

UNIT II - WINDOWS PROGRAMMING (9 hours)
Overview of windows programming – data types – resources –controls – interfaces – dynamic link libraries – SDK (Software development kit tools) – Context help

UNIT III - VISUAL BASIC PROGRAMMING (9 hours)
Form desi gn – overview – programming fundamentals – VBX controls – graphics applications – animation – interfaces – file system control – data control – data base application.

UNIT IV - VISUAL C++ PROGRAMMING (9 hours)
Frame work classes – VC++ components – resources handling – event handling – message dispatch system – model and model-less dialogues – importing VBX

controls – document – view architecture – sterilization – multiple document – splitter windows – co-ordination between controls – sub classing.

UNIT V - CASE STUDIES (9 hours)

Application to Mechanical Engineering problems - Mini Project

REFERENCES

1. David Kurlinski .J, "*Inside visual C++*", Microsoft press 1993.
2. Visual Basic 6 Complete, BPB Publications, New Delhi.
3. Holznek "*Visual C++ Programming*", Heavy Metal.
4. Microsoft Visual C++ and Visual Basic Manuals.
5. Plewolds, "*Windows Programming*"

	GROUP TECHNOLOGY AND CELLULAR MANUFACTURING	L	T	P	C
ME2218	Total Contact Hours-45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
To emphasis 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 solving4. Implementation of CMS				
3.	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. and 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.

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, http://www.it-weise.de/, 2009.
2. Rao .S.S, "*Optimization – Theory and Applications*", Wiley Eastern, New Delhi, 2009.
3. Hans Paul Schwefel, "*Evolution and Optimum Seeking*", Wiley-Interscience, 1995.

	DESIGN OF EXPERIMENTS	L	T	P	C
ME2216	Total Contact Hours-45	3	0	0	3
	Prerequisite				
	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: JohnWiley 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. Lazic .Z.R, "*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.

	ROBOT VISION	L	T	P	C
ME2311	Total Contact Hours-45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE	
To impart basic knowledge of robot vision, image processing and its applications.	
INSTRUCTIONAL OBJECTIVES	
To make the student to understand	
1.	Basic principle of image acquisition and imaging components
2.	Fundamentals of image processing and image enhancement
3.	Object recognition and feature detection
4.	Thinning and propagation algorithm
5.	Various application of robot

UNIT I - IMAGE ACQUISITION AND IMAGING COMPONENTS (9 hours)

The Nature of Vision- Robot vision – Need, Applications - image acquisition – illumination techniques- Point sensor, line sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation, picture coding techniques.

UNIT II - ELEMENTS OF IMAGE PROCESSING TECHNIQUES (12 hours)

Discretization, Neighbours of a pixel-connectivity- Distance measures - preprocessing Neighbourhood averaging, Median filtering. Smoothening 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- Recognition procedure, mahalanobic procedure

UNIT IV - COLLISON FRONTS ALGORITHM (6 hours)
Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects.

UNIT V - ROBOT VISION APPLICATION (9 hours)
Case study-Automated Navigation guidance by vision system – vision based depalletizing- line tracking-. Automatic part Recognition. Image processing techniques implementation through Image Processing software-MATLAB/OPENCV

REFERENCES

1. Janaki Raman .P.A, "*Robotics and Image Processing an Introduction"*, Tata Mc Graw Hill Publishing company Ltd., 1995.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "*Robotics Engineering an Integrated Approach, Phi Learning*", 2009.
3. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "*Industrial Robotics, Technology Programming and Applications"*, Tata McGraw-Hill Education, 2011.
4. John J. Craig, "*Introduction to Robotics Mechanics and Control"*, Third Edition, Pearson, 2008.
5. Bijay K. Ghosh, Ning Xi, Tarn .T.J, "*Control in Robotics and Automation Sensor – Based integration"*, Academic Press, 1999.
6. Deb .S.R, "*Robotics Technology and flexible automation"*, Tata McGraw-Hill Education., 2009.
7. Fu .K.S, Gonzalez .R.S, Lee .C.S.G, "*Robotics – Control Sensing, Vision and Intelligence*", Tata McGraw-Hill Education, 2008.
8. Rafel C.Gonzalez, Richard E.Woods,Steven L.Eddins, "*Digital Image Processing using MATLAB"*, 2nd edition, Tata McGraw Hill, 2010.

	ROBOTIC SIMULATION	L	T	P	C
ME2312	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				

PURPOSE	
To study the techniques of simulation for robot design.	
INSTRUCTIONAL OBJECTIVES	
To learn	
1.	To simulate the robot functions and joint movements.
2.	To learn a simulation package
3.	Graphic animation sequences for robot movement.
4.	Velocity, acceleration analysis of joint and linkages

UNIT I - INTRODUCTION (8 hours)

Robotics systems, Robot movements, Quality of simulation, types of simulation, Robot applications, Robotics simulation displays. Simulation notation, Auto lisp functions. Features, Command syntax, writing design functions.

UNIT II - ROBOTIC PRINCIPLES (8 hours)

Straight lines, Angles and optimal moves circular interpolation, Robotic functions Geometrical commands, Edit commands. Selecting robot views, standard Robot part, using the parts in a simulation.

UNIT III - ROBOTICS SIMULATION (10 hours)

Simulation packages, Loading the simulation, Simulation editors, delay, Resume commands. Slide commands, program flow control. Robot motion control, Analysis of robot elements, Robotic linkages.

UNIT IV - ROBOTIC MOTION (9 hours)

Solids construction, Solid animation. Types of motion, velocity and acceleration, Types of simulation motion Harmonic motion, parabolic motion, uniform motion velocity and acceleration analysis for robots.

UNIT V - ROBOT DESIGN (10 hours)

Linkages, Types, Transmission elements Flexible connectors, pulley-and-Belt drives, variable speed transmission. Design of Robot for particular applications – A case study.

REFERENCES

1. Daniel L. Ryan, "*Robotics Simulation*", CRC Press Inc., 1994.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "*Robotics Engineering an Integrated Approach*", Phi Learning., 2009.
3. Robert J. Schilling, "*Fundamentals of Robotics Analysis and Control*", PHI Learning., 2009.
4. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "*Industrial Robotics, Technology Programming and Applications*", McGraw Hill, 2012.

5. Francis N. Nagy, Andras Siegler, "*Engineering foundation of Robotics*", Prentice Hall Inc., 1987.
6. Robert J. Schilling, "*Fundamentals of Robotics Analysis and Control*", PHI Learning, 2009.
7. Tsuneo Yohikwa, "*Foundations of Robotics Analysis and Control*", the MIT Press, 2003.
8. John J. Craig, "*Introduction to Robotics Mechanics and Control*", Third Edition, Pearson, 2008.
9. Bijay K. Ghosh, Ning XI, Tarn .T.J, "*Control in Robotics and Automation Sensor – Based integration*", Academic Press, 1999.
10. Carl D. crane III and Joseph Duffy, "*Kinematic Analysis of Robot manipulation*", Cambridge University press, 2008.

	ROBOTIC SENSORS	L	T	P	C
ME2313	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				

PURPOSE

To provide knowledge of sensors used in Robotics

INSTRUCTIONAL OBJECTIVES

To make the student to understand

1. The basics and the latest technology of sensors used in robotics.
2. The different sensing variables
3. Robot vision system
4. Robot programming

UNIT I - INTRODUCTION (4 hours)

An Introduction to sensors and Transducers, History and definitions, Smart Sensing, AI sensing, Need of sensors in Robotics.

UNIT II - SENSORS IN ROBOTICS (10 hours)

Position sensors – optical, non-optical, Velocity sensors, Accelerometers, Proximity Sensors – Contact, non-contact, Range Sensing, touch and Slip Sensors, Force and Torque Sensors.

UNIT III - MISCELLANEOUS SENSORS IN ROBOTICS (11 hours)

Different sensing variables – smell, Heat or Temperature, Humidity, Light, Speech or Voice recognition Systems, Telepresence and related technologies.

UNIT IV - VISION SENSORS IN ROBTICS (10 hours)

Robot Control through Vision sensors, Robot vision locating position, Robot guidance with vision system, End effector camera Sensor.

UNIT V - MULTISENSOR CONTROLLED ROBOT ASSEMBLY (10 hours)

Control Computer, Vision Sensor modules, Software Structure, Vision Sensor software, Robot programming, Handling, Gripper and Gripping methods, accuracy – A Case study.

REFERENCES

1. Paul W Chapman, "*Smart Sensors*", an Independent Learning Module Series, 1996.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "*Robotics Engineering an Integrated Approach"*, Phi Learning., 2009.
3. John Iovice, "*Robots, Androids and Animations*", Mc Graw Hill, 2003.
4. Gonzalez Fu .K.S, .R.C, Lee .C.S.G, "*Robotics – Control Sensing, Vision and Intelligence*", Tata McGraw-Hill Education, 2008.
5. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "*Industrial Robotics, Technology Programming and Applications"*, Tata McGraw-Hill Education, 2012.
6. Sabrie Soloman, "*Sensors and Control Systems in Manufacturing",* McGraw-Hill Professional Publishing, 2nd Edition, 2009.
7. Julian W Gardner, "*Micro Sensor MEMS and Smart Devices"*, John Wiley & Sons, 2001.

ME2314	FUNDAMENTALS OF ARITIFICAL INTELLIGENCE FOR ROBOTICS	L	T	P	C
	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				

PURPOSE	
To expose the students to the fundamentals of AI and expert systems and its application in Robotics.	
INSTRUCTIONAL OBJECTIVES	
To familiarize the students with the	
1.	Fundamental concept of AI and expert system.
2.	Concept of AI programming languages.
3.	Applications of AI in the field of Robotics.

UNIT I - INTRODUCTION (6 hours)

Introduction – History, Definition of AI, Emulation of human cognitive process, Intelligent agents – The concept of rationality, the nature of environments, the structure of agents.

UNIT II - SEARCH METHODS (12 hours)

Problem – Solving Agents : Problem Definitions, Formulating Problems, Searching for solutions – Measuring Problem – Solving Performance with examples. Search Strategies : Uninformed search strategies – Breadth – first Search, Uniform – Cost Search, depth –first search, depth – limited search, Iterative deepening depth – first search, bidirectional search, comparing uniformed search strategies. Informed search strategies – Heuristic information, Hill climbing methods, best – first search, branch – and – bound search, optimal search and A* and Iterative deepening A*.

UNIT III - ROBOTICS (10 hours)

Introduction, Robotic perception – localization, mappings planning to move – configuration space, cell decomposition methods, skeletonization methods, Planning uncertain movements – Robust methods. Moring –dynamics and control, Potential Field control, reactive control, Robotics software architecture, Applications.

UNIT IV - PROGRAMMING AND LOGICS IN ARTIFICIAL INTELLIGENCE (10 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 WERS, non-deductive inference methods.

UNIT V - EXPERT SYSTEM (7 horus)

Expert system – Introduction, difference between expert system and conventional programs, basic activities of expert system – Interpretation, Prediction, Diagnosis, Design, Planning, Monitoring, Debugging, Repair, Instruction, Control. Basic aspects of expert system – Acquisition module, Knowledge base – Production rules, semantic net, frames. Inference engine – Backward chaining and forward chaining. Explanatory interface.

REFERENCES

1. Russell Stuart, Norvig Peter, *"Artificial Intelligence Modern Approach"*, Pearson Education series in AI, 3rd Edition, 2010.
2. Dan.W. Patterson, "*Introduction to Artificial Intelligence and Expert Systems*", PHI Learning, 2009.
3. Donald A. Waterman, "*A guide to Expert Systems*", Pearson, 2002.

ME2315	MODERN MATERIAL HANDLING SYSTEM	L	T	P	C
	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To expose the students with latest material handling system used in industry.					
INSTRUCTIONAL OBJECTIVES					
To study the					
1.	Basics of material handling system.				
2.	Various material handling equipment used in industry.				
3.	AGV's AS/RS system, conveyor systems.				
4.	Application of Robotics in material handling				

UNIT I - INTRODUCTION (9 hours)

Material Handling – Functions, Types, analysis, Importance & Scope, Principles, - Part feeding device – types of material handling system – Unit material movement & Unit loads – Receiving, Shipping, inprocess handling – bulk handling equipment & methods.

UNIT II - MATERIAL HANDLING EQUIPMENT (9 hours)

Industrial trucks, lifting device, monorails, manipulators, conveyors, storage systems, elevators, racks, bins, pallets, cranes – Automation of material handling – mechanization of part handling.

UNIT III - AUTOMATED GUIDED VEHICLE SYSTEM (9 hours)

Types of AGV's – Guidance techniques – Painted line, wire guided, vision guided method – Applications – Vehicle guidance & routing – Traffic control & safety – system management – Quantitative analysis of AGV system.

UNIT IV - STORAGE SYSTEM (9 hours)

Conveyor systems – types, Quantitative relationship & analysis – Automated storage system, performance – AS/RS system – Basic components, types, controls, features, applications, Quantitative analysis – carousel storage system – applications.

UNIT V - ROBOTICS IN MATERIAL HANDLING (9 hours)

General considerations in robot material handling – material transfer application – pick & place operations – machine loading & unloading – characteristics of robot application – Robot cell design – processing operations – Spot welding, Spray painting, Plastic moulding, forging.

REFERENCES

1. Mikell P. Groover, "*Automated Production System & Computer Integrated Manufacturing",* Prentice Hall of India ,1987.
2. Mikell P Groover, "*Industrial Robotics" ,* McGraw Hill ,1986.
3. Allegeri, Theodove . H, "*Material Handling Principle & Practice",* C.B.S. Publisher ,1987.
4. Alexandrov .M.P & Rudenko .N, "*Material Handling Equipments",* MIR Publisher , 1981.
5. Govindan .K.R, "*Plant Layout & Material Handling",* Anuradha agency, 2001.
6. *"Material Handling Equipment for the Manufacturing Industry",* AICTE, 1995.
7. Measwani .N.V & Mehta .A.C, "Advances in Material Handling Equipment".

ME2316	ROBOT ECONOMICS	L	T	P	C
	Total Contact Hours-45	3	0	0	3

	Prerequisites				
	Nil				
PURPOSE					
To learn various economic and social aspects of Robotics and its installation procedure.					
INSTRUCTIONAL OBJECTIVES					
To learn					
1.	The various costs and potential benefits associated with the robot installation.				
2.	Several methods for analyzing these factors to determine economic merits of the project.				
3.	The logical sequences of the procedures to implement the robotic installation and social issues, applications.				

UNIT I - ROBOT COMPONENTS AND THEIRS SELECTION (8 hours)
Power supply, movement and drive systems, sensors, end effector and grippers, Control techniques, Characteristics and factor considered for selection.

UNIT II - ECONOMIC ANALYSIS FOR ROBOTICS (9 hours)
Economic analysis for robotics. Economic analysis, basic data required methods of Economic analysis, subsequent uses of robot, Difference in production rates, other factors Robot project analysis form.

UNIT III - IMPLEMENTING ROBOTICS (10 hours)
Familiarization with robotics technology, plant survey to identify potential applications, Selection of the best applications, Selection of a robot, Detailed economic analysis, planning and installation.

UNIT IV - SOCIAL ISSUES (8 hours)
Safety in Robotics, Training, Maintenance, Quality improvement, productivity and capital formation, Robotics and labour. Education and training, international impacts, future applications.

UNIT V - ROBOTICS TECHNOLOGY OF THE FUTURE (10 hours)
Robot intelligence, Advanced Sensors, Capabilities, Tele robotics, Mechanical design Features, Mobility, locomotion and Navigation. The universal Hand Systems Integration and Networking. Robots in RPT.

REFERENCES

1. Mikell P .Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "*Industrial Robotics, Technology Programming and Applications*", McGraw Hill, 2012.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "*Robotics Engineering an Integrated Approach*", Phi Learning., 2009.
3. Radhakrishnan .P, Srivatsavan .R, Mohan Ram .P.V and Radharamanan .R, CAD/CAM, "*Robotics and factories of the future, Proceeding of the 14th International Conference on CAR and FOF",* 98 editors, Narosa Publishing house, 2003.
4. Gonzalez Fu .K.S, . Lee R.S, .C.S.G, "*Robotics Control, Sensing Vision and Intelligence"*, Tata McGraw Hill Education, 2008.

	COMPUTER INTEGRATED DESIGN	L	T	P	C
ME2317	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				
	(The students are expected to write computer programs in C or C++ to automate machine elements design principles)				

PURPOSE

To study how computers can be used to automate machine element design.

INSTRUCTIONAL OBJECTIVES

To know the fundamentals of design and write programs in C or C++ to automate the design of shafts, power transmission systems (belts and gears), gear boxes, clutches and brakes for automobiles, machine tools and material handling equipments.

UNIT I - INTRODUCTION (9 hours)

Phases of design – properties of engineering materials – standardization and interchangeability of machine elements – Classes of fit, selecting tolerances, accumulation and non-accumulation of tolerance - Tolerance stack up stress concentration – Theories of failure.

UNIT II - SHAFT (9 hours)

Design of shaft for different application – Design for rigidity – Integrated design of shaft, key and bearing practical shaft Design using computer.

UNIT III - BELT DRIVES AND GEARS (9 hours)

Design of belt drives - Principle of gear tooth action – Gear correction - Gear tooth failure modes – Stress and loads – component design of spur, helical, bevel and worm gears, practical component design of gears using computer.

UNIT IV - GEAR BOXES (9 hours)

Integrated design of speed reducer and multi speed gear boxes - Housing, Bearing, Shaft, Capacity of lubricant, Gasket.

UNIT V - CLUTCHES AND BRAKES (9 hours)

Integrated design of automobile components: Clutches – Dynamic and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobiles and mechanical handling equipments.

REFERENCES

1. Newcomb .T.P and spur .R.T, "*Automobile Brakes and Braking Systems*", Chapman and Hall, 2nd edition, 1975.
2. Juvinall, RLC, "*Fundamental of Machine Component Design*", John wiley, 1983.
3. Maitra .G.M, "*Hand Book for Gear Design*", Tata McGraw Hill, 1985.
4. Shigley, "*Mechanical Engineering Design*", McGraw Hill, 1986.
5. Hall, Hocowenko, Laughlin, "*Theory and Problem of Machine Design*", Schaum`s outline series.
6. Aaron d.deutschman, Walter J.Michels and Charles e. Wilson "*Machine Design Theory and Practice*". Macmillan publishing co., Inc. New York. Collier Macmillan publishers, London.

	MANUFACTURING SYSTEM SIMULATION	L	T	P	C
ME2318	Total Contact Hours-45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE	
To highlight the basic concepts and procedure for simulation of Manufacturing systems	
INSTRUCTIONAL OBJECTIVES	
To familiarise	
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 - INRODUCTION (6 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 (9 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 (10 hours)

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

UNIT IV - SIMULATION LANGUAGES (10 hours)

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

UNIT V - DISCRETE EVENT SIMULATION (10 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.

ME2319	CNC MACHINING TECHNOLOGY	L	T	P	C

	Total Contact Hours-45	3	0	0	3
	Prerequisite				
	Nil				

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

Feedback 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

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.

	FINITE ELEMENT ANALYSIS	L	T	P	C
ME2320	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					
To study the basic principles and applications of the engineering analysis tool Finite Element Analysis.					
INSTRUCTIONAL OBJECTIVES					

1.	Introduction to Engineering Analysis tool FEA its application in Linear static Analysis and 2D problems
2.	Study of Finite Element modeling and simulation Techniques
3.	Use of FEA in structural vibration and thermal Analysis
4.	Study of Finite Element Software - ANSYS

UNIT I - INTRODUCTION (9 hours)

Basic concept of Finite Element Method, Historical background, FEM Applications, General Description of FEM, Commercial FEM software packages. Spring element-stiffness matrix, boundary conditions, solving equations. Variational formulation approach- Rayleigh-Ritz method, Principle of minimum Potential Energy, Weighted residual methods.

UNIT II - 1-D LINEAR STATIC ANALYSIS (9 hours)

Bar and Beam elements, local and global coordinate system, transformation of coordinate systems, element stress. Analysis of truss. Natural coordinate system, Interpolation polynomial, Isoparametric elements and Numerical integration - Gaussian quadrature approach-simple problems in 1-D.

UNIT III - FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS (9 hours)

Review of the basic theory in 2-D elasticity, plane stress, 2-D problems using Constant Strain Triangles (CST), isoparametric representation, element matrices, stress calculations. Finite element modeling and simulation techniques-symmetry, Nature of FE solutions, error, convergence, adaptivity, substructures (super elements) in FEA.

UNIT IV - STRUCTURAL VIBRATION AND DYNAMIC ANALYSIS (9 hours)

Review of basic dynamic equations, Hamilton's principle, element mass matrices, free vibration (normal mode) analysis, Eigen values and Eigen vectors. Introduction to transient response analysis.

UNIT V - THERMAL ANALYSIS (9 hours)

Review of basic equations of heat transfer, steady state one dimensional heat conduction, governing equations, boundary conditions, element characteristics-Simple problems in 1-D.

Practical: - 2-D, 3-D problems, introduction to transient heat transfer, simple problems using ANSYS.

REFERENCES

1. Chandrupatla & Belagundu, "*Finite Elements in Engineering*", Prentice Hall of India Private Ltd., 1997.

2. Rao .S.S, "*Finite Element Method in Engineering*", Pregamon Press, 1989.
3. Krishnamoorthy. C.S, "*Finite Element Analysis- Theory and Programming"*, Tata McGraw-Hill Publishing Co., 1987.
4. Reddy .J.N, "*An introduction to the Finite Element Method*", McGraw Hill Book Company New York; 1984.
5. Zienkiewicz .O.C, "*The Finite Element Method in Engg. Science*", McGraw-Hill, London, 1977.
6. Cook, Robert Davis et all, "*Concepts and Applications of Finite Element Analysis",* Willy, John & Sons, 1999.
7. Hubner .K.H, Donald .L.D, Smith .D.E, Ted G. Byron, "*The Finite Element Method for Engineers*", John, Willy & Sons, 1982.

WEB REFERENCES

1. http://www.cadcamnet.com
2. http://www.feaonline.com
3. http://www.ansys.com

ME 2321	PRINCIPLES OF COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
	Total Contact Hours-45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE	
To enable the students to understand the basic principles of CIM and its elements.	
INSTRUCTIONAL OBJECTIVES	
To familiarize	
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 (9 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 (9 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 (9 hours)

FMS concept, Components of FMS, FMS Layouts, FMS planning and implementation, . Tool Management systems-Tool monitoring, Work holding devices-Modular fixuring, 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 (9 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 (9 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.

	NANO ROBOTICS	L	T	P	C
ME2322	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				

PURPOSE	
To enlighten the students about nanorobot working principle and applications	
INSTRUCTIONAL OBJECTIVES	
At the end of this course the student should be able to understand the	
1.	Basics of nano robotics system
2.	Micro/Nano Sensors
3.	Micro/Nano Actuators
4.	Micro/Nano Manipulators
5.	Micro/Nano Robotics manufacturing and control techniques

UNIT I - INTRODUCTION (9 hours)

Micro/Nano-Robotic system components, Products-Scaling effects in the physical parameters -Micro/Nano-Robotic System examples around the world-wall climbing micro robot, Micro mechanical flying robot-Design, fabrication, characterization of micro gripper- Introduction to nanomanipulation, control and applications-Bottom up and Top down approach.

UNIT II - MICRO/NANO SENSORS (9 hours)

Nanoscale sensor- Bio sensor- Imaging Sensors - Position Sensors- Encoder, Resolver, and LVDT- Capacitive Sensors - Interferometric Sensors - STM Tips Based sensor- Force and Pressure Sensors - Strain Gauge – Thermal sensor -AFM - Visual Force Sensing – Accelerometers – Gyroscopes - Chemical Sensors - Flow Sensors.

UNIT III - MICRO/NANO ACTUATORS (9 hours)

Micro robot actuation- Piezoelectric Actuators - Bending Type - Unimorph and Bimorphs - Stack Type – Piezotubes - Thin-Film Type - Surface Acoustic Waves - Electrostatic, Thermal, Ultrasonic, Magnetostrictive actuators ,Shape memory alloy actuators - Polymer Actuators - Dielectric Elastomers - Carbon Nanotube (CNT) Actuators - Biomolecular Motors.

UNIT IV - MICRO/NANO MANIPULATORS (9 hours)

SPM Probes and Micro/Nanogrippers -Atomic Manipulation using STM, non-contact AFM, nanoassembly, Direct self-assembly - Optical Tweezers and Dielectrophoresis - Bio-Manipulation using Optical Tweezers - Carbon Nanotube Manipulation using Nanoprobes - High Density Data Storage Using Nanoprobes-Simple case study.

UNIT V - MANUFACTURING TECHNIQUES, NANO-ROBOT DESIGN (9 hours)
Micro/Nanofabrication techniques- Photo Lithography, Electron beam, X-Ray, Ion beam Lithography- LIGA process- Micro Stereo lithography Micro/Nano Assembly - Self-Assembly, human machine Interfacing -Biomimetics and Design Strategy - Kinematics and Dynamics of Robot- Teleportation Based, Task Based and Automatic Control Approaches.

REFERENCES

1. Elwenspoek .M and Wiegerink .R, "*Mechanical Microsensors"*, Springer-Verlag Berlin, 2001.
2. Israelachvili .J, "*Intermolecular & Surface Forces"*, Academic Press Ltd., 2nd Edition, 1992.
3. Norio Taniguchi, "*Nanotechnology"*, Oxford University Press, Cambridge, 1996.
4. Scherge .M and Gorb .S, "*Biological Micro- and Nano-tribology": Nature's Solutions",* Springer Verlag, Berlin Heidelberg, 2001.
5. Morris .V.J ,Kirby .R, Gunning .P, "*Atomic Force Microscopy for Biologists"*, London, Imperial College Press, 1999.
6. Dror Sarid, "*Scanning Probe Microscopy"*, Oxford University Press, Revised Edition, 1994.
7. Fatikow .S, Rembold .U, "*Microsystem Technology and Microrobotics"*, Springer Verlag, 1997.
8. Güntherodt .H.J, Anselmetti .D, Meyer .E, "*Forces in Scanning Probe Methods",* NASA Science Series, 1995.
9. Bhushan .B, *"Handbook of Micro/Nanotribology",* CRC Press, 2nd Ed., 1999.
10. Maugis .D, "*Contact, Adhesion and Rupture of Elastic Solids"*, Springer Verlag, Berlin, 2000.
11. Madou .M, "*Fundamentals of Microfabrication",* CRC Press, 1997.
12. Kovacs .G.T, "*Micromachined Transducers Sourcebook",* Mc-Graw-Hill Comp.inc., 1998.
13. Tai-Ran Hsu, "*MEMS and Microsystems Design and Manufacture"*, McGraw-Hill inc., 2002.

	COMPUTER GRAPHICS	L	T	P	C
ME2323	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				
PURPOSE					

To study how various graphics images can be created on the computer and its representation standards.	
INSTRUCTIONAL OBJECTIVES	
The students can understand the following	
1.	Basics of computer Graphics like drawing line, arc etc.
2.	Drawing of spline curves
3.	Creation of surfaces
4.	Algorithms for 3D viewing
5.	Available drawing standards

UNIT I - INTRODUCTION (9 hours)

Origin of computer graphics – interactive graphics display – display devices – pixels– algorithms for line and circle – Bresenham's algorithm – 2D and 3D transformations – translation, rotation, scaling – concatenation.

UNIT II - SPECIAL CURVES (9 hours)

Curve representation – Bezier, cubic spline, B-spline, rational.

UNIT III - SURFACES (9 hours)

Surface modeling techniques: Coons patch, Bi-cubic patch, Bezier and B-spline surfaces.

UNIT IV - THREE DIMENSIONAL COMPUTER GRAPHICS (9 hours)

Volume modeling: boundary representation, CSG, hybrid - viewing transformations – techniques for visual realism: clipping, hidden line removal, algorithms for shading and rendering.

UNIT V - GRAPHICS STANDARDS & FUNDAMENTALS OF COMMUNICATIONS (9 hours)

GKS – bitmaps – Open GL Data exchange standards – IGES – STEP – CALS – DXF – STL Communication standards – LAN, WAN.

REFERENCES

1. Chris McMohan and Jimmi Browne, "*CAD/CAM Principles, Practice and Manufacturing Management*", Pearson Education Asia, Ltd., 2000.
2. Donald Hearn and Pauline Baker .M, "*Computer Graphics*", Prentice Hall, Inc., 1992.
3. Ibrahim Zeid "*CAD/Cam Theory and Practice*", McGraw Hill, International Edition, 1998.
4. Khandare .S.S, "*Computer Aided Design*", Charotar Publishing House, India, 2001.
5. Newman, William M., & Sproull, Robert F., "*Principles of Interactive Computer Graphics*", 2nd Ed., McGraw Hill, 1981.

6. Harington, Stevan, "*Computer Graphics: A Programming Approach*", McGraw Hill, 1983.
7. Plastock, Roy .A, & Kally, "*Theory and Problems of Computer Graphics*", McGraw Hill, 1986.
8. Rogers .D.F, "*Procedural Elements for Computer Graphics*", McGraw Hill, 1985.
9. Foley .J.D. & Van dam .A, "*Fundamentals of Interactive Computer Graphics*", Addison – Wesley, 1982.
10. Vosinet, Donald. "*Computer Aided Drafting and Design: Concepts & Applications*", McGraw Hill, 1986.

	OPTIMIZATION IN ENGINEERING DESIGN	L	T	P	C
ME2324	Total Contact Hours-45	3	0	0	3
	Prerequisites				
	Nil				

PURPOSE	
To study the principles of optimization and various techniques which can be used for Mechanical Engineering optimization along with applications.	
INSTRUCTIONAL OBJECTIVES	
1.	Principles of optimization and its need.
2.	Various conventional optimization techniques
3.	Solving multivariable problems
4.	Solving problems using Unconventional optimization techniques
5.	Applications of optimization to design of machine elements

UNIT I - INTRODUCTION (9 hours)

Introduction to optimization – adequate and optimum design – principles of optimization – statement of an optimization problem – classification – formulation of objective function, design constraints.

UNIT II - CLASSICAL OPTIMIZATION TECHNIQUES (9 hours)

Single variable optimization –multivariable optimization with no constraints – exhaustive search, Fibonacci method, golden selection, Random, pattern and gradient search methods – Interpolation methods: quadratic and cubic, direct root method.

UNIT III - MULTIVARIABLE – UNCONSTRAINED AND CONSTRAINED OPTIMIZATION (9 hours)

Direct search methods – descent methods – conjugate gradient method. Indirect methods – Transformation techniques, penalty function method

UNIT IV - NON – TRADITIONAL OPTIMIZATION TECHNIQUES (9 hours)

Genetic Algorithms - Simulated Annealing - Tabu search methods.

UNIT V - OPTIMUM DESIGN OF MACHINE ELEMENTS (9 hours)

Desirable and undesirable effects – functional requirement – material and geometrical parameters – Design of simple axial, transverse loaded members for minimum cost and minimum weight – Design of shafts, springs, Vibration absorbers.

REFERENCES

1. Rao .S.S, "*Optimization – Theory and Applications*", Wiley Eastern, New Delhi, 1978.
2. Fox .R.L, Optimization Methods for Engineering Design, Addition – Wesley, Reading, Mass, 1971.
3. Wilde .D.J, "*Optimum Seeking Methods*", Prentice Hall, Englewood Cliffs, New Jersey, 1964.
4. Johnson, Ray .C, "*Optimum Design of Mechanical Elements*", 2nd Ed., John Wiley & sons, Inc., New York, 1980.

SUPPORTIVE COURSES

	COMPUTATIONAL METHODS IN ENGINEERING	L	T	P	C
MA2006	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.

	APPLIED MATHEMATICS FOR MECHANICAL ENGINEERS	L	T	P	C
MA2007	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					
1.	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. Sastry .S.S, "*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.

	MOBILE ROBOT	L	T	P	C
ME2391	Total contact hours - 45	3	0	0	3
	Prerequisite				
	Nil				

PURPOSE

To familiarize the students with mobile robots, basic methods for achieving mobility and autonomy.

INSTRUCTIONAL OBJECTIVES

Upon successful completion of the course the students will be able to understand

1. Design and kinematic modeling of mobile robots
2. Basic control algorithms involved in mobile robots
3. Various sensors used for perception
4. The localization and mapping
5. Various algorithms in path planning and navigation

UNIT I - INTRODUCTION TO MOBILE ROBOTS (9 hours)

Introduction to Mobile robots - Locomotion, Classification - Legged, Wheeled, Aerial. Key issues in locomotion. Mobile Robot Kinematics - Kinematic model- Forward Kinematic model, Representing position, Wheel kinematic constraints. Motion control.

UNIT II - CONTROL OF MOBILE ROBOTS (9 hours)

Control theory - Control design basics, Cruise-Controllers, Performance Objectives. Simple robot – State space model, Linearization, LTI system, stability. PID control, basic control algorithms

UNIT III - PERCEPTION (9 hours)

Sensors for mobile robots – Classification, performance, uncertainty in sensors, wheel sensor, heading sensor, accelerometers, inertial measurement, motion sensor, range sensors. Vision sensor- Basics of computer vision, image processing techniques, feature extraction – image, range data location recognition.

UNIT IV - LOCALIZATION (9 hours)

Major challenges, localization based navigation. Belief representation, map representation, probabilistic Map. Examples of localization systems. Autonomous map building

UNIT V - PLANNING AND NAVIGATION (9 hours)

Planning and Reaction- Path Planning – graph search, D* algorithm, Potential field. Obstacle avoidance – bug algorithm, histogram, curvature velocity techniques. Navigation architecture. Case studies

REFERENCES

1. Siciliano. et al, "*Robotics: Modelling, Planning and Control*", 3rd Edition, Springer, 2009.
2. Choset. et al, "*Principles of Robot Motion: Theory, Algorithm & Implementations*", MIT Press, 2005.
3. Thrun, Burgard, Fox, "*Probabilistic Robotics*", MIT Press, 2005.
4. Siegwart, Nourbakhsh, "*Introduction to Autonomous Mobile Robots*", MIT Press, 2004.
5. Siciliano, Khatib, Eds, "*Handbook of Robotics*", Springer, 2008.

	SEMINAR	L	T	P	C
ME2396	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.

	PROJECT WORK PHASE I	L	T	P	C
ME2397	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.

	PROJECT WORK PHASE II	L	T	P	C
ME2398	Prerequisite	0	0	32	16
	Nil				

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