Savitribai Phule Pune University

Faculty of Science & Technology

Syllabus Structure

Master of Engineering

Production

(Robotics and Automation)

(2020 Course)

(with effect from June 2020)

Savitribai Phule Pune University, Pune
Master of Engineering- Production (Robotics and Automation) (2020 Course)
(with effect from A.Y. 2020-21)

Semester I

Course Code	Course	Teaching Scheme (Hrs./Week)		Examination Scheme and Marks					Credit Scheme	
		Theory	Practical	In-Sem	End-Sem	TW	OR/PR	Total	TH	PR
511501	Computational Mathematics	03		50	50			100	03	
511502	Robot Control System	03		50	50			100	03	
511503	Robotics Based Industrial Automation	03		50	50			100	03	
511504	Research Methodology	03		50	50			100	03	
511505	Elective I	04		50	50			100	04	
511506	Laboratory Proficiency I		08			50	50	100		04
	Total	**16**	**08**	**250**	**250**	**50**	**50**	**600**	**16**	**04**
	Total Credit								**20**	
	*Non Credit Course I								Grade	

Elective I

511505-A	Mechatronics Systems and Applications	511505-B	Instrumentation and Sensors
511505-C	Flexible manufacturing systems	511505-D	CAD/CAM
511505-E	Open Elective		

Savitribai Phule Pune University, Pune
Master of Engineering-Production (Robotics and Automation) (2020 Course)
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Semester II

Course Code	Course	Teaching Scheme (Hrs./Week)		Examination Scheme and Marks					Credit Scheme	
		Theory	Practical	In-Sem	End-Sem	TW	OR/PR	Total	TH	PR
511507	Robot Programming	03		50	50			100	03	
511508	Advanced Robot kinematics and Dynamics	03		50	50			100	03	
511509	Robot vision system	03		50	50			100	03	
511510	Elective II	04		50	50			100	04	
511512	Mini project with Seminar I		03			50	50	100		03
511513	Laboratory Proficiency II		08			50	50	100		04
	Total	**13**	**11**	**200**	**200**	**100**	**100**	**600**	**13**	**07**
	Total Credit								**20**	
	*Non Credit Course II								Grade	

Elective II

511510-A	Service Robots	511510-B	Signal Processing
511510-C	Wireless Networks	511510-D	Pneumatic and Hydraulic Control
511510-E	Open Elective		

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Semester III

Course Code	Course	Teaching Scheme (Hrs./Week)		Examination Scheme and Marks					Credit Scheme	
		Theory	Practical	In-Sem	End-Sem	TW	OR/PR	Total	TH	PR
611501	Artificial Intelligence in Robotics	03		50	50			100	03	
611502	Soft Computing in Robotics	03		50	50			100	03	
611503	Elective III	04		50	50			100	04	
611504	Industry Internship –I/In-house research project I		03			50	50	100		03
611505	Dissertation Stage I		08			50	50	100		08
	Total	**10**	**11**	**150**	**150**	**100**	**100**	**500**	**10**	**11**
	Total Credit								**21**	
	*Non Credit Course III								Grade	

Elective III

611503-A	Programming and Data Structure	611503-B	Simulation and Modeling
611503-C	MEMS and Microsystems	611503-D	Mobile and Autonomous Robots
611503-E	Open Elective		

Savitribai Phule Pune University, Pune
Master of Engineering-Production (Robotics and Automation) (2020 Course)
(with effect from A.Y. 2020-21)

Semester IV

Course Code	Course	Teaching Scheme (Hrs./Week)		Examination Scheme and Marks					Credit Scheme		
		Theory	Practical	In-Sem	End-Sem	TW	OR/PR	Total	TH	TW	PR
611504	Industry Internship –II/In-house research project II	--	03			50	50	100	03		
611505	Dissertation Stage II	--	18			150	50	200	18		
	Total	**--**	**21**			**200**	**100**	**300**	**21**		
	Total Credit								**21**		

*A particular Non-credit course can be selected only once.

Non-Credit Courses

Typically, curriculum is constituted by credit, non-credit and audit courses. These courses are offered as compulsory or elective. Non-Credit Courses are compulsory. No grade points are associated with non-credit courses and are not accounted in the calculation of the performance indices SGPA & CGPA. However, the award of the degree is subject to obtain a PP grade for non-credit courses. Conduction and assessment of performance in said course is to be done at institute level. The mode of the conduction and assessment can be decided by respective course instructor. Recommended but not limited to- (one or combination of) seminar, workshop, MOOC Course certification, mini project, lab assignments, lab/oral/written examination, field visit, field training. Examinee should submit report/journal of the same. Reports and documents of conduction and assessment in appropriate format are to be maintained at institute. Result of assessment will be PP or NP. Set of non-credit courses offered is provided. The Examinee has to select the relevant course from pool of courses offered. Course Instructor may offer beyond this list by seeking recommendation from authority. The selection of 3 distinct non-credit courses, one per semester (Semester I, II & III). The Contents of Non-Credit Courses are provided at the end of the document.

NCC1	Research Paper Writing		**NCC6**	Pedagogy Studies
NCC2	Disaster Management		**NCC7**	Stress Management
NCC3	Risk Management		**NCC8**	Personality Development
NCC4	Value Education		**NCC9**	Change Management
NCC5	Constitution of India		**NCC10**	Virtual Reality

Computational Mathematics

511501

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit-I: Mathematical Stochastic Processes: **(7)**

Definition and examples of SPs; Definition and examples of Markov Chains (MCs): transition probability matrix, Chapman-Kolmogorov equations; calculation of n-step transition probabilities; limiting probabilities; Classification of states; Ergodicity; Stationary Distribution, transient MC; random walk and gambler's ruin problem, applications. Kolmogorov- Feller differential equations

Unit-II: Computer based Numerical Techniques. **(7)**

Roots of non-linear equations, Solution of system of linear equations, Interpolation methods, Numerical integration

Unit-III: Computational Methods for Differential Equations **(7)**

Solution of partial differential equations using Lagrange's method of undetermined multipliers, Charpit's method; Complete solution of homogeneous and non-homogeneous L.P.D.E. of higher order with constant and variable coefficients. Linear homogeneous Boundary Value Problems, Eigen values and Eigen functions, Sturm Liouville Boundary Value Problems, Non-homogeneous Boundary Value Problems,

Unit-IV : Graphs and Combinatorial Optimization:

Graphs and Digraphs: Computer representation of Graphs and Digraphs. Shortest path problems- Complexity, Bellman's Optimality Principle, Dijktra's Algorithm, Sortest Spanning Trees Kruskal's Greedy Algorithm. Networks. Flow augmenting Paths. Ford-Fulkerson Algorithm for Maximum Flow.

Unit-V: Numerical optimization: **(7)**

Introduction to optimization: basics, classifications & characteristics, linear programming: concepts, solving method, applications. Nonlinear programming: Concepts, solving methods, examples. Dynamic programming method. Traveling salesman problem, Transportation problem

Unit-VI : Multi-variable and vector calculus: **(7)**

Introduction, vector functions, multivariable derivatives, implications of multi-variable derivatives, multiple integrals, Vector fields and vector calculus

References:

1. Joseph D. Fehribach, Multivariable and Vector Calculus, Walter de Gruyter GmbH & Co KG, 2020
2. Boyce and Diprime, Elementary Differential Equations and Boundary Value Problems, Wiley, 2008
3. M. D. Raisinghania, Advanced Differential Equations, S. Chand Publications, 2008
4. Papoulis, A., Pillai, S.U., Probability, "Random Variables and Stochastic Processes", Tata McGraw-Hill, 4th Ed. 2002.
5. J. Medhi, Stochastic Processes, 3rd Edition, New Age International, 2009.
6. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi. 2000.
7. S Haykin, Neural Networks: A Comprehensive Foundations, Pearson,
8. S. S. Rao, Engineering Optimization: Theory and Applications, 4th Ed. Wiley, 2009.
9. Erwin Kreyszig "Advanced Engineering Mathematics"8th Edition. John Wiley & Sons

Robot Control system

511502

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit-I: Dynamics of Electromechanical Systems **(7)**

Basic Quantities: Elements and Basic Quantities in Mechanical Systems, Elements and Basic Quantities in Electric Systems, Fundamental Concepts of Mechanical Systems, The Principle of Least Action, Dynamics, Non-potential and Dissipative Forces, Equations of Motion, Properties of Equations of Motion, Operational Space Dynamics, Electric and Electromechanical Systems, Electrical Systems, Electromechanical Systems, Electrical Machines

Unit -II Control System Design **(7)**

Basic Concepts Basic Forms in Control Systems ,Basic Relations, Stability, Sensitivity Function, External Inputs, State Space Representation: State Feedback, Stability, Observers, Systems with Observers, Disturbance Estimation, Dynamic Systems with Finite Time Convergence: Equivalent Control and Equations of Motion, Existence and Stability, Design, Control in Linear Systems, Sliding Mode Based Observers

Unit -III Acceleration Control (7)

Plant, Acceleration Control, Formulation of Control Tasks, Equivalent Acceleration and Equivalent Force, Enforcing Convergence and Stability, Convergence for Bounded Control Input, Systems with Finite-Time Convergence, Equations of Motion, General Structure of Acceleration Control, Trajectory Tracking

Unit -IV Disturbance Observers (7)

Disturbance Model Based Observers, Velocity Based Disturbance Observer, Position Based Disturbance Observer, Closed Loop Disturbance Observers, Internal and External Forces Observers, Observer for Plant with Actuator Plant with Neglected Dynamics of Current Control Loop, Plant with Dynamics in Current Control Loop, Estimation of Equivalent Force and Equivalent Acceleration, Functional Observers, Dynamics of Plant with Disturbance Observer, Disturbance Estimation Error, Dynamics of Plant With Disturbance Observer, Properties of Measurement Noise Rejection, Control of Compensated Plant

Unit-V Interactions and Constraints **(7)**

Interaction Force Control: Proportional Controller and Velocity Feedback, Environment with Losses, Lossless Environment, Control of Push Pull Force, Constrained Motion Control, Modification of Reference, Modification by Acting on Equivalent Acceleration, Motion Modification while Keeping Desired, Force Profile, Impedance Control, Force Driven Systems, Position and Force Control in Acceleration, Dimension, Interactions in Functionally Related Systems, Grasp Force Control , Functionally Related Systems.

Unit-VI Bilateral Control Systems (7)

Bilateral Control without Scaling, Bilateral Control Design, Control in Systems with Scaling in Position and Force, Bilateral Control Systems in Acceleration Dimension, Bilateral Systems with Communication Delay, Delay in Measurement Channel, Delay in Measurement and Control Channels, Closed Loop Behavior of System with Observer, Bilateral Control in Systems with Communication Delay

References:

1. R Kelly, D. Santibanez, LP Victor and Julio Antonio, “Control of Robot Manipulators in Joint Space”, Springer, 2005.
2. A Sabanovic and K Ohnishi, “Motion Control Systems”, John Wiley & Sons (Asia), 2011.

3. R M Murray, Z. Li and SS Sastry, “A Mathematical Introduction to Robotic Manipulation”, CRC Press, 1994.
4. J J Craig, “Introduction to Robotics: Mechanics and Control”, Prentice Hall, 2004.
5. J J E Slotine and W Li, “Applied Nonlinear Control”, Prentice Hall, 1991.
6. Sebastian Thrun, Wolfram Burgard, Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.
7. Carlos, Bruno, Georges Bastin, “Theory of Robot Control”, Springer, 2012

Robotics Based Industrial Automation

511503

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit- I: Introduction **(8)**

Definition, automation principles and strategies, scope of automation, socio-economic consideration, low cost automation, basic elements of advanced functions, Information processing in manufacturing industry, Production concepts and automation strategies.
Fixed Automation: Automated Flow lines, Methods of Work part Transport, Transfer Mechanism - Continuous transfer, intermittent transfer, Indexing mechanism, Operator-Paced Free Transfer Machine, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations.
Modeling Automated Manufacturing Systems: Role of Performance Modeling, Performance Measures, Performance Modelling Tools: Simulation Models, Analytical Models.

Unit- II: Introduction to Industrial Robots: **(8)**

Definitions, Types of Robots, Application of Robots, Representing Position and Orientation, Representing Pose in 2-Dimensions, Representing Pose in 3-Dimensions, Representing Orientation in 3-Dimensions, Combining Translation and Orientation.

Unit –III: Time and Motion **(8)**

Trajectories, Smooth One-Dimensional Trajectories, Multi-Dimensional Case, Multi-Segment Trajectories, Interpolation of Orientation in 3D, Cartesian Motion, Time Varying Coordinate Frames, Rotating Coordinate Frame, Incremental Motion, Inertial Navigation Systems. Mobile Robot Vehicles, Mobility, Car-like Mobile Robots, Moving to a Point, Following a Line, Following a Path, Moving to a Pose.

Unit –IV: Robot Arm Kinematics **(8)**
Describing a Robot Arm, Forward Kinematics, A 2-Link Robot, A 6- Axis Robot, Inverse Kinematics, Closed-Form Solution, Numerical Solution, Under-Actuated Manipulator, Redundant Manipulator, Trajectories, Joint-Space Motion, Cartesian Motion, Motion through a Singularity

Unit- V: Getting Started with ROS for Industrial Application: **(8)**
Installing ROS, Understanding the ROS Filesystem level, Packages, Stacks, Messages, Services, Understanding the ROS Computation Graph level, Nodes, Topics, Services, Messages, Bags, Master, Parameter Server, Creating workspace, Creating & Building an ROS package, Creating & Building the node, Visualization of images, Working with stereo vision, 3D visualization, Visualizing data on a 3D world using rviz

Unit –VI: Robot Programming for Industrial applications: **(8)**
Using Sensors and Actuators with ROS, SCORBOT structure, joint movements, work envelop, motors, encoders, microswitch, transmission, gripper, SCORBOT programming, IS-14533 : 2005 Manipulating industrial robots - Performance criteria related test methods, Mobile Robot Programming, Industrial Robot Programming.
PLC: Introduction, Micro PLC, Programming a PLC, Logic Functions, Input & Output Modules,PLC Processors, PLC Instructions, Documenting a PLC System, Timer & Counter Instructions, Comparison & Data Handling Instructions, Sequencing Instructions, Mask Data Representation, Typical PLC Programming Exercises for Industrial Applications.

References:

1. M.P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education.
2. Krishna Kant ,“Computer Based Industrial Control” –, EEE-PHI
3. Webb John Principles and Applications of PLC –, McMillan 1992
4. Tiess Chiu Chang & Richard A. Wysk “An Introduction to Automated Process Planning Systems”
5. Amber G.H & P.S. Amber “Anatomy of Automation”, Prentice Hall.
6. Peter Corke Robotics, Vision and Control: Fundamental Algorithms in MATLAB® -, Springer Tracts in Advanced Robotics, Volume 73, 2011 2.
7. Aaron Martinez & Enrique Fernández ,Learning ROS for Robotics Programming, Packt Publishing
8. Yoram Koren , Robotics for Engineers -, McGraw Hill International, 1st edition, 1985.
9. M. Weiss, R. N. Nagel, M. P. Groover, Industrial Robotics , McGraw Hill International, 2nd edition, 2012.
10. Fu, Lee and Gonzalez. Robotics, control vision and intelligence- McGraw Hill International, 2nd edition, 2007.
11. John J. Craig , Introduction to Robotics-, Addison Wesley Publishing, 3rd edition, 2010.

Research Methodology

511504

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit –I: Introduction **(7)**

Nature and objectives of research. Methods of Research: historical, descriptive and experimental, research process, research approaches, criteria for good research, problems faced by researchers

Unit –II: Research Design **(7)**

Meaning of research design, need of research design, features of good design, different research designs, basic principles of experimental designs, design of experiments.

Unit-III: Data Collection **(7)**

Types of data, methods and techniques of data collection, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection, pilot study and pretest of tools, choice of data collection methods.

Unit-VI: Processing and Analysis of Data **(7)**

Use of statistics for data analysis, measures of central tendency, dispersion, skewness and relationship. Sampling distributions, sampling theory, determination of sample size, chi-square test, analysis of variance, multiple regression analysis, neural networks.

Unit-V: Decision Making Techniques **(7)**

Multi-attribute decision making techniques: Analytical Hierarchy Process (AHP), TOPSIS, Data Envelope Analysis (DEA), graph theory and matrix approach.

Multi-objective decision making techniques: Simulated annealing, Genetic algorithms.

Unit-VI: Interpretation and Report Writing **(7)**

Techniques of interpretation, precautions in interpretation, significance of report writing, different steps in report writing, layout of research report, mechanics of writing research report.

References:

1. C.R Kothari “Research Methodology” Wishwa Prakashan, ISBN: 8173280363
2. P.G Triphati “Research Methodology” Sultan Chand & Sons, New Delhi.
3. J. W Barnes, “Statistical Analysis for Engineers and Scientists” McGraw Hill, New York.
4. Ranjit Kumar “Research Methodology” Pearson Education, ISBN: 9788131704967
5. Rao R. V. “Decision making in the manufacturing environment using graph theory and fuzzy multiple attribute decision making” Springer-Verlag, London. ISBN: 1846288193
6. Rao S. S., “Optimization”, Wiley Eastern, New Delhi, 1995. ISBN: 0471550345
7. Montgomery D.C., “Design and analysis of experiments”, John Wiley & Sons, ISBN: 0470128666.

Elective-1

Mechatronics Systems and Applications

511505-A

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Introduction to Mechatronics **(8)**

Introduction to Mechatronics - Systems - Mechatronics in Products – Measurement Systems – Control Systems - Traditional design and Mechatronics Design.

Unit –II: Sensors and Transducers **(8)**

Introduction - Performance Terminology - Displacement, Position and Proximity -Velocity and Motion –Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing – Servo systems.

Unit –III: Microcontrollers **(8)**

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

Unit –IV: Input output Systems **(8)**

Interfacing requirements, interface adapters, buffers, Tri-state buffers, hand shaking and Serial interfacing. Parallel interfacing, Function of synchronous communication, Networks.

Unit –V: Programmable Logical Controllers **(8)**

Basic structure of PLC, program of PLC, logic functions, latching and sequencing, Develop programs involving timers, internal relays, counters, shift registers, PLC Programming.

Unit –VI: Mechatronics Systems & Applications **(8)**

Case studies of Mechatronic systems designs, like piece counting system, Pick and place manipulator, Simple assembly task involving a few parts, Part loading / unloading system, Automatic tool and pallet changers etc. Fault finding and troubleshooting.

References:

1. Bolton, “Mechatronics: Electronic Control System in Mechanical and Electrical Engineering”, Pearson Education Ltd. ISBN:8131732533
2. B. H. Histard, D. G. Alciator, “Introduction to Mechatronics and Measurement Systems”, Tata McGraw Hill Publication, ISBN 0-07-052970-8.
3. B. C. Kuo, “Automatic Control Systems”, prentice Hall, ISBN 0-87-692480-1.
4. Programmable Logical Controller”, Hackworth, Pearson Education, (2008)
5. C. D. Johnson, “Process Control Instrumentation Technology”, Prentice Hall of India Pvt. Ltd., New Delhi.
6. D. Shetty, R. Kolk, “Mechatronics System Design”, Thomson Books Pub., ISBN98-1240062-2.
7. AppuKuttam “Mechatronics”, Oxford Publications, 1st Edition.
8. Gary Dunning, “Programmable Logical Controller”, Cengage Learning, 3rd Edition.
9. Ramesh. S Gaonkar, “Microprocessor Architecture, Programming and Applications", Wiley Eastern,1998. ISBN:0130195707

Elective-1

Instrumentation & Sensors

51105-B

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit -I : Sensor Based Measurement Systems **(8)**

General Concepts And Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics Of Measurement Systems, Dynamic Characteristics, Other Sensor Characteristics, Primary Sensors, Materials For Sensors, Microsensors Technology.

Unit- II : Displacement, Force, Pressure Sensors. **(8)**

Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, Measurement of pressure using LVDT based diaphragm & piezoelectric sensor.

Unit- III: Temperature, Position, Proximity, Flow and Level Sensors. **(8)**

Measurement of temperature using Thermistor, Thermocouple & RTD, Concept of thermal imaging, Measurement of position using Hall effect sensors, Proximity sensors: Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors: Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive.

Unit -IV: DAQ Methods **(8)**

Data Acquisition Methods: Basic block diagram, Analog and Digital IO, Counters, Timers, Types of ADC: successive approximation and sigma-delta, Types of DAC: Weighted Resistor and R-2R Ladder type, Use of Data Sockets for Networked Communication.

Unit -V: Intelligent Sensors **(8)**

Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.

Unit -VI: Virtual Instrumentation **(8)**

Virtual Instrumentation: Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs, Structures: Case, Sequence & Formula nodes, Need of software based instruments for industrial automation.

References:

1. D. Patranabis, “Principle of Industrial Instrumentation”, Tata McGraw Hill
2. DVS Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013
3. S. Gupta, J.P. Gupta / PC interfacing for Data Acquisition & Process Control, 2nd ED / Instrument Society of America, 1994.
4. Gary Johnson / Lab VIEW Graphical Programing II Edition / McGraw Hill 1997
5. Bolton, “Mechatronics: Electronic Control System in Mechanical and Electrical Engineering”, Pearson Education Ltd. ISBN:8131732533

6 D. Shetty, R. Kolk, “Mechatronics System Design”, Thomson Books Pub., ISBN98-1240062-2.

10. E.O. Doebelin, “Measurement Systems”, McGraw Hill.
11. Arun K. Ghosh, Introduction to measurements and Instrumentation, PHI, 4th Edition 2012
12. A.D. Helfrick and W.D. Cooper, Modern Electronic Instrumentation & Measurement Techniques, PHI – 2001

Elective1

Flexible Manufacturing Systems

511505-C

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Introduction **(8)**

Introduction to manufacturing system, different type of manufacturing system, volume variety relationship for understanding manufacturing system.

Flexible Manufacturing System: Components of an FMS, types of system, where to apply FMS technology, FMS work stations. Material handling and storage system: Functions of the handling system, FMS layout configuration, Material handling equipment.

Unit- II : Distributed data processing in FMS **(8)**

DBMS and their applications in CAD/CAM and FMS distributed systems in FMS –Integration of CAD and CAM - Part programming in FMS, tool data base - Clamping devices and fixtures data base.

Unit- III: Group Technology **(8)**

Cellular Manufacturing-Part families, part classification and coding. Types of classification and coding system, Machine cell design: The composite part concept, types of cell design. Virtual Cell Manufacturing System.

Just In Time and Lean Production: Lean Production and Waste in manufacturing, just in time production system, automation, work involvement.

Unit -IV: Production Planning and control systems **(8)**

Aggregate Production Planning and the master production schedule, Material Requirements and Planning, capacity planning, shop floor control, inventory control, extensions of MRP

Computer Aided Process Planning: Generative and variant types, backward and forward approach, feature based and CAD based CAPP.

UNIT-V : FMS-Support Systems **(8)**

Contact and non-contact inspection principles - programming and operation-in cycle gauging. Part programming in FMS, tool data base - Clamping devices and fixtures data base. Material Handling systemsin FMS: Conveyors - AGVs – industrial robots in material handling - AS/RS.

UNIT-VI: Computer control system **(8)**

Computer function, FMS data file, system reports planning the FMS, analysis method for FMS, application and benefits. Interfacing of computers, machine tool controllers and handling systems: communications standards Programmable Logic Controllers (PLC's) – Interfacing, Computer aided Project planning- dynamic part scheduling.

References:

1. Paul Ranky., “The design and operation of FMS”, IFS publication
2. Mikell P Groover, “Automation Production systems, Computer Integrated Manufacturing”, Prentice Hall
3. David J. Parrish, “Flexible Manufacturing” Butterworth-Heinemann, 1990
4. Computer Aided Manufacture by Chien Chang and Richard A Wysk, Prentice HALL
5. P. Radhakrishnan, S. Subramanyan, “CAD / CAM / CIM”, New Age International.
6. William W Luggen, “Flexible Manufacturing Cells and System” Prentice Hall of Inc New Jersey, 1991
7. Reza A Maleki “Flexible Manufacturing system” Prentice Hall of Inc New Jersey, 1991
8. John E Lenz “Flexible Manufacturing” Marcel Dekker Inc New York ,1989.

Elective-I

CAD/CAM

511505-D

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

UNIT- I: Introduction **(8)**

Brief introduction – definition, Types of Manufacturing, evolution of CIM, CIM hardware and CIM software, Nature and role of the elements of CIM System, Development of CIM,

Product development through CIM – product development cycle, Sequential Engineering vs Concurrent engineering, implementation of concurrent engineering, CE and Information technology, soft and hard prototyping, Characteristics of CE, key factors influencing the success of CE.

UNIT- II: Production Planning and Control and Computerised Process Planning **(8)**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems

UNIT –III: Automation and Intelligent Machines **(8)**

Basic Group Technology layouts, process layouts, product layouts, Comparison of process and product layouts, designing process layouts – block diagramming, relationship diagramming, service layouts, designing product layouts – Line balancing, Coding System - Simple Problems in Opitz Part Coding system. Machines for flexible automation, Controllers, Sensors, Intelligent machines.Customer/Supplier communication – network and distribution.

UNIT –IV: Flexible Manufacturing System **(8)**

Flexible manufacturing Systems vs dedicated manufacturing systems, cellular manufacturing systems, major elements of FMS, FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems, problems with FMS. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT- V: Distributed Numerical Control **(8)**

DNC system – communication between DNC computer and machine control Unit – hierarchical processing of data in DNC system – features of DNC system. Adaptive control in Machine control Unit. Networking concepts, LOSI, MAP, TOP, LAN, WAN, Communication interface, bus architecture, topologies, and protocols .Manufacturing data base.

UNIT –VI: Robots in Computer Integrated Manufacturing **(8)**

Robot Anatomy and Related Attributes – Classification of Robots- Performance capabilities, programming robots, geometric requirements to the CAD/Robot linkage, Simulation, Adaptive control, Robot operation, End of Arm tooling, control system operation, Application of industrial robot, integration of industrial robot into a CIM system.

References:

1. A. Alavudeen, N.Venkateshwaran, “Computer Integrated Manufacturing”, PHI Learning Private Ltd. ISBN: 978-81-203-3345-1
2. P. Radhakrishnan, S.Subramanyan, V.Raju, “CAD/CAM/CIM”, New Age International Ltd. ISBN: 81-224-1248-3
3. Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.

4. August-Wilhelm Scheer, “CIM. Computer Integrated Manufacturing: Towards the Factory of the Future”, Springer
5. Alan Weatherhall,” Computer Integrated Manufacturing: From Fundamental to implementation”, Butterworth & Co. Ltd, ISBN: 0-408-00733-8
6. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 2003.
7. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach” Chapman & Hall, London, 1995.

Open Elective 1

Optimization Techniques

511505-E

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit-I: Introduction to Optimization **(7)**

Statement of an optimization problem, classification. Introduction to optimization techniques, Engineering Applications

Unit-II: Single Variable Optimization **(7)**

Fabbonci search methods, golden section search methods, gradient based methods, Newton-Raphson method, secant method.

Unit-III: Multi-variable Optimization **(7)**

Direct search methods: Evolutionary optimization method, Powell's conjugate direction method. Gradient based methods: Steepest descent method, Newton's method.

Unit-IV: Constrained Optimization **(7)**

Constraint handling methods, method of feasible directions, generalized reduced gradient method, gradient projection method.

Unit-V: Specialized Algorithms **(7)**

Integer programming, geometric programming**.**

Unit-VI: Non-Traditional Optimization Algorithms **(7)**

Genetic algorithms (GA) - working principle, Differences and Similarities between GA's and traditional methods, GA's for constrained optimization. Simulated Annealing (SA) approach – introduction only.

References:

1. Rao S S "Engineering Optimization: Theory and Practice", John Wiley & Sons. ISBN: 0470183527
2. Kalyanamoy Deb, "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall of India, New Delhi. ISBN: 812030943X
3. A. D. Belegundu, T. R. Chandrupatla "Optimization Concepts and Applications in Engineering", Wiley Students Edition. ISBN: 0521878462
4. R. Fletcher, "Practical Methods of Optimization", John Wiley & Sons. ISBN: 0471494631

Laboratory Proficiency I

511506

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 8 hrs/week	PR:4	TW-50 Marks
		OR/PR-50 Marks

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1. Industrial case study on design of experiment
2. Industrial case study on multi-attribute decision making
3. Numerical solution of a partial differential equation by using different methods
4. Manufacturing application of T test and Chi-square test.
5. Microcontroller lab – programming (free software /open source)
6. Integration of assorted sensors (IR, Potentiometer, strain gages etc.),
7. Micro controllers and ROS (Robot Operating System) in a robotic system. (Free software, Matlab)
8. Control experiment using available hardware or software. (Open source or Matlab).

Robot Programming

511507

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit -I : Basics Of Robot Programming **(10)**

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, JoggingTypes, Robot specifications- Motion commands, end effectors and sensors commands

Unit- II : VAL Language **(9)**

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)**

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)**

Robot cycle time analysis-Multiple robot and machine Interference-Process chartSimple 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. 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.

UNIT –VI: Robot Programming Applications **(9)**

Robot programming synthesis, robot programming for foundry, press work and heat treatment, welding, machine tools, material handling, warehousing assembly, etc., automatic storage and retrieval system, Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning.

References:

1. Deb. S. R. “Robotics Technology and Flexible Automation”, Tata McGraw Hill publishing company limited.
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.

Advanced Robot Kinematics and Dynamics

511508

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit I: Elements of robots – links, joints, actuators, and sensors **(7)**

Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Unit II: Kinematics of serial robots **(7)**

Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator.

Unit III: Kinematics of parallel robots **(7)**

Degrees-of- freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop-closure equations, Direct kinematics problem, Mobility of parallel manipulators, Closed-from and numerical solution, Inverse kinematics of parallel manipulators and mechanisms, Direct kinematics of Gough-Stewart platform.

Unit IV: Velocity and static analysis of robot manipulators **(7)**

Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics.

UNIT V: Dynamics of serial and parallel manipulators **(7)**

Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, Examples of a planar 2R and four-bar mechanism, Recursive dynamics, Commercially available multibody simulation software (ADAMS) and Computer algebra software Maple.

UNIT VI: Motion planning and control **(7)**

Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Nonlinear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators

References:

1. Ghosal,A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, “Robotics: Control, Sensing, Vision, and Intelligence,” McGraw-Hill Inc., Boston
3. Mark Spong, M. Vidyasagar: Robot Dynamics & Control (Wiley)
4. Hartenberg and Denavit, : Kinematics and Synthesis of Linkages", McGraw Hill Book Co
5. Herman Bruyninckx, : Robot Kinematics and Dynamics,

Robot Vision System

511509

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Vision System: **(8)**

Camera Geometry and Color Sensing, Basic Components - Elements of visual perception: structure of human eye, image formation in the eye – pinhole cameras - colour cameras – image formation model – imaging components and illumination techniques - picture coding – basic relationship between pixels - Camera-Computer interfaces, Image capture and digitization

Unit -II: Low Level Vision Algorithms: **(8)**

Sources of imagery, physics of imaging, Representing, acquiring, and displaying images, Grayscale, color, noise, lens distortion, and filtering. Image representation – image transformation & calibration, gray level transformations, Histogram equalization, image subtraction, image averaging – Filters: smoothing spatial filters, sharpening spatial filters, smoothing frequency domain filters, sharpening frequency domain filters - edge detection, image Convolution,

Unit -III: High Level Vision Algorithms: **(8)**

Image Segmentation (based on discontinuity and similarity), Edge linking and boundary detection, thresholding, Region-oriented segmentation, the use of motion – Description: Boundary Descriptors, Regional Descriptors, Recognition: Decision-Theoretic methods, structural methods. Enhancing features and correcting imperfections, addressing noise, lens distortion, and blurring, Image Morphing, Image Blending, Image Carving, Image transforms; digital Fourier transform, fast Fourier transform, other transforms, correlation; image enhancement; image restoration; Geometric transformation; image compression; error free and lossy compression; edge detection; hough transform, region based segmentation; image feature/region representation and descriptors.

Unit -IV: Object Recognition: **(8)**

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values, SVM and Object Recognition

Unit -V: Applications: **(8)**

Camera Calibration - Stereo Imaging - Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering, Kalman Filtering.

Unit -VI: Robot Vision: **(8)**

Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV – The cv_bridge Package

References:

1. Horn, Berthold K. P. *Robot Vision*. Cambridge, MA: MIT Press /McGraw-Hill, March 1986. ISBN: 0262081598.
2. Damian m Lyons, “Cluster Computing for Robotics and Computer Vision”, World Scientific, Singapore, 2011.
3. Carsten Steger, Markus Ulrich, Christian Wiedemann, “Machine Vision Algorithms and Applications”, WILEY-VCH, Weinheim, 2008.
4. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Addition – Wesley Publishing Company, New Delhi, 2007.
5. Shimon Ullman, “High-Level Vision: Object recognition and Visual Cognition”, A Bradford Book, USA, 2000.
6. R.Patrick Goebel, “ ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I”, A Pi Robot Production, 2012.
7. Bernd Jahne, “Digital Image Processing”, Springer Publication, 2013.

Elective-II

Service Robots

511510- A

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Introduction **(8)**

History of service robotics – Present status and future trends – Need for service robots - Applications- Examples and Specifications of service and field Robots. Non-conventional Industrial robots the humanoid robots functions & its operations.

Unit- II: Localization **(8)**

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization.

Unit- III: Planning and Navigation **(8)**

Introduction-Path planning overview- Road map path planning- Cell decomposition path planning-Potential field path planning-Obstacle avoidance - Case studies: Tiered robot architectures.

Unit- IV: Field Robots **(8)**

Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater,Civilian and military applications, Nuclear applications, Space applications.

Unit- V: Humanoids **(8)**

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications- Case studies.

Unit - VI: Domestic and Medical Robotics **(8)**

Introduction to home automation, domestic robotics, cleaning robots, lawn moving robots, challenges and applications. Introduction to medical robotics, historical background, surgical robots, rehabilitation robots, exoskeletons, issues related to safety and ethics, applications and challenges in medical robotics.

References:

1. Roland Siegwart, Illah Reza Nourbakhsh, DavideScaramuzza, „Introduction to Autonomous Mobile Robots‖, Bradford Company Scituate, USA, 2004
2. Riadh Ziaer (Ed) „The future of Humanoid Robots- Research and applications‟, Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011
5. Groover M. P., “Industrial Robotics: Technology, Programming and Applications, Tata McGraw Hill Publication
6. Taghirad H.D, “Parallel Robots: Mechanics and Control”, CRC Press.
7. Moore S. W., Bohm H., and ,Jensen V., “Underwater Robotics: Science, Design & Fabrication”, Marine Advanced Technology Education (MATE) Center, 2010
8. Mejia O. D. M., Gomez J. A. E., (eds.), “Aerial Robots: Aerodynamics, Control and Application” InTech Open Publications.
9. Bock T., Linner T., “Robot Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction”, Cambridge University Press,

10. Robotics and Mechatronics for Agriculture, by Zhang D., Wei B., (eds.), CRC Press.
11. Medical Robotics, by Schweikard A., Ernst F., Springer Publications
12. Household Service Robotics, by Xu Y., Qian H., and Wu X., Zhejiang University Press.
13. Springer Handbook of Robotics, by Khatib O., (ed.), Springer Publications.
14. Humanoid Robotics: A Reference, Vadakkepat P., Goswami, A.,Springer Netherlands, 2017.
15. On Road Intelligent Vehicles, by Kala R., Elsevier Publications, 2017

Elective-II

Signal Processing

511510- B

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit- I: Introduction to Signals & Systems **(8)**

Signals: Introduction, Graphical, Functional, Tabular and Sequence representation of Continuous and Discrete time signals. Basics of Elementary signals: Unit step, Unit ramp, Unit parabolic, Impulse, Sinusoidal, Real exponential, Complex exponential, Rectangular pulse, Triangular, Signum, Sinc and Gaussian function.
Operations on signals: time shifting, time reversal, time scaling, amplitude scaling, signal addition, subtraction, signal multiplication. Communication, control system and Signal processing examples.
Classification of signals: Deterministic, Random, periodic , Non periodic, Energy , Power, Causal , Non-Causal, Even and odd signal.
Systems: Introduction, Classification of Systems: Lumped Parameter and Distributed Parameter System, static and dynamic systems, causal and non-causal systems, Linear and Non- linear systems, time variant and time invariant systems, stable and unstable systems, invertible and non- invertible systems.

Unit- II: Time domain representation of LTI System **(8)**

Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral using graphical method for Unit step to Unit step, Unit step to exponential, exponential to exponential, Unit step to rectangular and rectangular to rectangular only. Computation of convolution sum. Properties of convolution. System interconnection, system properties in terms of impulse response, step response in terms of impulse response.

Unit- III: Fourier Series **(8)**

Fourier series (FS) representation of periodic Continuous Time (CT) signals, Dirichlet condition for existence of Fourier series, orthogonality, basis functions, Amplitude and phase response, FS representation of CT signals using trigonometric and exponential Fourier series. Applications of Fourier series, properties of Fourier series and their physical significance, Gibbs phenomenon.
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Unit- IV: Fourier Transform **(8)**

Fourier Transform (FT) representation of a periodic CT signals, Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response, FT of standard CT signals, Properties and their significance, Interplay between time and frequency domain using sinc and rectangular signals, Fourier Transform for periodic signals.
DTFT, Definition, Frequency domain sampling , DFT, Properties of DFT, circular convolution, linear convolution

Unit- V: Laplace Transform **(8)**

Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, ROC, Properties of ROC, Laplace transform of standard periodic and aperiodic functions, properties of Laplace transform and their significance, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, stability considerations in S domain, Application of Laplace transforms to the LTI system analysis.

Unit- VI :Application of Signal Processing in Robotics and Automation (8)

Applications of signal processing in robotic sectors: Autonomous navigation, robot teams or swarms of robots and target tracking. Remote health monitoring, neurobiological surveillance systems and fall detection for aged patients.

References:

1. Simon Haykins and Barry Van Veen, “Signals and Systems”, Wiley India, 2 nd Edition.
2. M.J. Roberts “Signal and Systems”, Tata McGraw Hill 2007.
3. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and applications” Fourth edition, Pearson Prentice Hall.
4. S. Salivahanan, C. Gnanpriya, “Digital Signal processing”, McGraw Hill
5. Charles Phillips, “Signals, Systems and Transforms”, Pearson Education, 3 rd Edition.
6. Peyton Peebles, “Probability, Random Variable, Random Processes”, Tata McGraw Hill, 4 th Edition.
7. A. Nagoor Kanni “Signals and Systems”, McGraw Hill, 2 nd Edition
8. Dr. Shaila Apte, “Digital Signal Processing” Wiley India Publication, second edition
9. K.A. Navas, R. Jayadevan, “Lab Primer through MATLAB”, PHI
10. Li Tan, Jean Jiang, “Digital Signal Processing: Fundamentals and applications“ Academic press

Elective-II

Wireless Networks

511510- C

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit- I : Wireless LAN **(8)**

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security - IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX

Unit- II : Mobile Network Layer **(8)**

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunnelling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing.

Unit- III: Mobile Transport Layer **(8)**

TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP - TCP over 3G wireless networks.

Unit- IV: Wireless Wide Area Network **(8)**

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3G-MSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed Downlink packet access (HSDPA)- LTE network architecture and protocol.

Unit- V: 4G Networks **(8)**

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

Unit- VI: 5G Networks **(8)**

5G Architecture: Software Defined Networking – Network Function Virtualization – Basics about RAN Architecture –High-Level Requirements for 5G Architecture – Functional Architecture and 5G Flexibility – Physical Architecture and 5G Deployment Millimeter Wave Communication: Channel Propagation – Hardware Technologies for mmWave Systems – Deployment Scenarios – Architecture and Mobility – Beamforming – Physical layer Techniques

References:

1. Next Generation Wireless LANs by EldadPerahia, Robert Stacey
2. Wireless Networks by Clint Smith and Daniel Collins
3. 802.11 Wireless Networks: The Definitive Guide, Second Edition
4. Designing and Deploying 802.11ac Wireless Networks by Jim Geier
5. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012.(Unit I,II,III)
6. Vijay Garg , "Wireless Communications and networking", First Edition, Elsevier 2007.
7. Wireless Networking Absolute Beginner's Guide by Michael Miller
8. Computer Networking First-Step by Norman Laurence
9. Networking Made Easy by James Bernstein
10. WiFi Analytics by Luke Buikema and John Kerbers
11. Wireless Communication Networks and Systems, by Cory Beard and William Stallings

Elective-II

Pneumatics and Hydraulics Control

511510- D

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit- I: Fluid Power Principles and Hydraulic Pumps **(8)**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory, Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

Unit- II: Hydraulic Actuators and Control Components **(8)**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

Unit- III: Hydraulic Circuits and Systems **(8)**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit- IV: Pneumatic and Electro Pneumatic Systems **(8)**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

Unit- V: Trouble Shooting and Applications **(8)**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

Unit –VI: Pneumatic Control Valves **(8)**

DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control:Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling. Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications

References:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw- Hill, 2001.
3. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
4. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
5. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995

6. Michael J, Prinches and Ashby J. G, “Power Hydraulics”, Prentice Hall, 1989.
7. Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, Chand & Co, 2006.

Open Elective 2

Engineering Economics and costing

511510-E

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit-I: Introduction to economics **(8)**

Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics, Managerial, Economics and Macro-economics - Applications of Economics, Elementary economic Analysis – Material and design selection criteria, Process planning.

Unit-II: Financial Management **(8)**

Responsibilities and functions of financial management, financial analysis, ratio analysis, leverage analysis, budgeting and budgetary control, sources of finance for fixed and working capital.

Unit-III: Investment Appraisal Method **(8)**

Types of investment appraisal methods – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, make or buy decisions, Examples in all the methods, risk analysis.

Unit-IV: Replacement and Maintenance Analysis **(8)**

Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

Unit-V: Depreciation Analysis **(8)**

Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, machine hour basis method, production Unit method, joint factor rate method, annuity method, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Unit-VI: Costing, Const Control and Cost Reduction **(8)**

Process costing: Elements of production cost in process costing, methods of process costing, principles of process costing. Marginal costing: Features of marginal costing, significance of marginal costing, breakeven point, P/V ratio. Standard costing and variance analysis: Direct material variances, direct labor variances, Overhead variances, sales variances. Cost control and cost reduction, Techniques of cost control, cost reduction, areas of application.

References:

1. Dominick Salvatore, “Managerial economics in a global economy” McGraw-Hill. ISBN: 0070545995
2. Panneer Selvam, R, Engineering Economics, Prentice Hall of India Ltd, New Delhi, 2001.ISBN: 8120317432
3. Sasmita Mishra, Engineering Economics and Costing. PHI Learning Pvt. Ltd. ISBN: 8120338936
4. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2002. ISBN: 0136118488
5. William G. Sullivan, Elin Wicks and C.Patrick Koelling, “Engineering economy”, Pearson Education, ISBN:9788131734421

Mini project with Seminar I

510512

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	PR: 3	TW-50 Marks
		PR/OR-50 Marks

Conduction guidelines: Industry or research internship should include partial/ complete project implementation. Student should be allocated to the research guide in first semester itself and same guide should be continued for the**:** Industry Internship-I/ In house Research Project –I. Otherwise the preferences/ choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/ choices. The research project should be assigned to students. In case of Industry Internship-I, the assigned guide from college has to monitor and evaluate the progress of the student. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

Laboratory Proficiency II

511513

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 8hrs/week	PR:4	TW-50 Marks
		PR-50 Marks

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1. Study components of an industrial robot (Kuka, Mitsubishi, Fanuc, ABB etc.) and its DH parameters.
2. Forward kinematics and validation using a software (Robo Analyser/ MatLab or any other free software tool).
3. Inverse kinematics of an industrial robot and validation using any open source software.
4. Industrial Robot programming using RAPID, MELFA, VAL II or equivalent.
5. Use of open source computer vision programming tool/ MatLab, open CV.
6. Research related experiment in AI, e.g. multi agent system, unmanned systems control using ROS, etc.
7. Small group project work relevant to Industrial automation.

Artificial Intelligent in Robotics

611501

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Scope of AI and Problem solving **(8)**

Introduction to Artificial Intelligence-Introduction, Intelligent agents,
Problem solving by search, Adversarial search.

Unit- II: Planning: **(8)**

The planning problem, planning with state-space search, partial-order planning, planning graph, planning with propositional logics. Planning & acting in the real world.

Unit -III: Knowledge Representation& Learning **(8)**

Uncertainty, probabilistic reasoning-Bayesian Network, probabilistic reasoning over time-Inference in temporal Model, Hidden Markov models-Kalman filters, Dynamic Bayesian Network, speech recognition.
Learning: Concept of learning, learning automation, genetic algorithm, learning by inductions, neural nets.
Programming Language: Introduction to programming Language. Handling Uncertainties: Non-monotonic reasoning, Probabilistic reasoning, use of certainty factors, Fuzzy logic

Unit -IV: Expert system **(8)**

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 Unit, Knowledge base – Production rules, semantic net, frames. Inference engine – Backward chaining and forward chaining. Explanatory interface.

Unit -V: Communication & Perception **(8)**

Communication, Probabilistic language processing-probabilistic-language models-information retrieval-extraction-machine translation, perception-image formation- image processing operations-object recognition

Unit -VI: AI in Robotics: **(8)**

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics. Case study of AI in robotics.

References:

1. Stuart Russell, Peter Norvig, Artificial Intelligence: A modern approach, Pearson Education, India.
2. Negnevitsky, M, Artificial Intelligence: A guide to Intelligent Systems,. Harlow: Addison-Wesley, 2002.
3. E. Rich and K. Knight, “Artificial intelligence”, TMH, 2nd ed..
4. Nilsson, N. J. (1986). Principles of artificial intelligence. Morgan Kaufmann.
5. Craig, J. J. (2009). Introduction to robotics: mechanics and control, 3/E. Pearson Education India.
6. D.W. Patterson, “Introduction to AI and Expert Systems”, PHI, 1992.
7. Peter Jackson, “Introduction to Expert Systems”, AWP, M.A., 1992.
8. R.J. Schalkoff, “Artificial Intelligence - an Engineering Approach”, McGraw Hill Int. Ed., Singapore, 1992.
9. M. Sasikumar, S. Ramani, “Rule Based Expert Systems”, Narosa Publishing House, 1994.

Soft Computing in Robotics

611502

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	TH:3	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Evolutionary algorithms **(8)**

Evolutions strategies and evolutionary programming, Genetic algorithms, introduction to classifier systems, genetic programming,

Unit-II: Algorithms based on Swarm Intelligence **(8)**

Particle swarm optimization, ant colony optimization, artificial bee colony optimization, shuffled frog leaping algorithm, firefly algorithm, grey wolf optimization, back widow optimization. Portfolio optimization

Unit -III: Artificial Neural Networks **(8)**

Artificial neurons, Networks of Artificial Neurons, Neural Learning, Supervised Learning, Unsupervised Learning, Fault Tolerance, Artificial Neural Nets and Statistics, ANN data selection, Evolutionary Design of Artificial Neural Networks: Evolving weights, network architecture, learning rules etc.

Unit -IV: Fuzzy systems **(8)**

Fuzzy sets, fuzzy relations, the extension principle, fuzzy arithmetic, fuzzy logic, possibility theory, applications of fuzzy systems. Evolutionary Design of Fuzzy rule based Systems: Evolving fuzzy decision rules, fuzzy queries, fuzzy filters.

Unit -V: Neuro-fuzzy Systems **(8)**

Fuzzy Neural Networks, Cooperative Neuro-fuzzy Systems, Applications of Neuro-fuzzy Systems, Fuzzy Control of Evolution, Fuzzy Evolutionary Algorithms, Natural Parallel Soft Computing

Unit -VI: Applications of Soft computing in robotics **(8)**

Soft computing in robotics applications such as: Robot path planning, Trajectory generation, inverse kinematics and dynamics, Robotic controller design, robot clustering, robot sorting, robot collaboration, Obstacle avoidance etc.

Books:

1. Samir Roy, Udit Chakraborty, 'Soft Computing', Pearson Education India, 2013, ISBN: 9789332514201
2. D. K. Pratihar, 'Soft Computing' Alpha Science International, 2008, ISBN: 9781842654378
3. S.N.Sivanandam, S.N.Deepa, 'Principles of Soft Computing', John Wiley & Sons, 2007, ISBN: 9788126510757
4. Pawar P. J., 'Evolutionary Computations for Manufacturing', Studium Press, 2019, ISBN: 9789385046520

Elective-III

Programming and Data Structure

611503-A

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: C Programming Fundamentals **(8)**

Introduction to the basic ideas of problem solving and programming using principles of top-down modular design, Flowcharts, Compilation of a Program with examples Conditional statements.

Unit -II: C Programming Advanced Features **(8)**

Data Types, Instruction and its Types, Storage Classes, Operators and Hierarchy of Operations, Expressions in C, Control and Repetitive Statements, break, continue, Arrays, Strings.

Unit- III: Introduction to Data Structure **(8)**

Basic terminologies; introduction to basic data Structures: Arrays, linked list, trees, stack, queue, Graph; Data structure operations; Algorithm complexity: definition, types and notations .

Unit -IV: Linear Data Structures **(8)**

Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation –– singly linked lists- circularly linked lists- doubly-linked lists – applications of lists –Polynomial Manipulation – All operation (Insertion, Deletion, Merge, Traversal)

Unit -V: Linear Data structures **(8)**

Stack ADT – Evaluating arithmetic expressions- other applications- Queue ADT – circular queue implementation – Double ended Queues – applications of queues

Unit- VI: Sorting, Searching and Hash Techniques **(8)**

Sorting algorithms: Insertion sort – Selection sort – Shell sort – Bubble sort – Quick sort – Merge sort – Radix sort – Searching: Linear search –Binary Search Hashing: Hash Functions – Separate Chaining – Open Addressing – Rehashing Extendible Hashing

References:

1. Robert Kruise, C L Tondo and Bruce Leung, "Data Structures"
2. Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language”, 2nd Edition, Pearson Education, 1988.
3. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education, 1997.
4. “Schaum’s Outline of Programming with C” by Byron Gottfried
5. Data structures: A Pseudocode Approach with C, 2nd edition,
6. R.F.Gilberg and B.A. Forouzan, “data Structures” Cengage Learning.
7. M.A.Weiss, Data structures and Algorithm Analysis in C, 2nd edition, Pearson.
8. A.M.Tanenbaum,Y. Langsam, M.J.Augenstein, Data Structures using C, Pearson.
9. R.Kruse, C.L.Tondo and B.Leung, Data structures and Program Design in C, 2nd edition, Pearson
10. R G Dromey, “How to Solve it by Computer” , Pearson Education

Elective-III

Simulation and Modeling

611503-B

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Introduction modelling strategy **(8)**

System, environment, input and output variables, State variables; Static and Dynamic systems; Hierarchy of knowledge about a system and Modeling Strategy.

Introduction of Physical Modeling: Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models

Unit -II : Modelling of System with Known Structure **(8)**

Review of conservation laws and the governing equation for heat, mass and momentum transfer, Deterministic model-(a) distributed parameter models in terms of partial identification and their solutions and (b) lumped parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modelling for control

Unit -III: Optimizations and Design of Systems **(8)**

: Summary of gradient based techniques: Nontraditional Optimizations techniques genetic Algorithm (GA)-coding, GA operations elitism, Application using MATLAB: Simulated Annealing.

Unit- IV: Neural Network Modeling of Systems only with Input-output Database: **(8)**

Neurons, architecture of neural networks, knowledge representation, learning algorithm. Multilayer feed forward network and its back propagation learning algorithm, Application to complex engineering systems and strategy for optimum output

UNIT-V: Modeling Based on Expert Knowledge: **(8)**

Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers

UNIT-VI : Simulation of Engineering Systems: **(8)**

Monte-Carlo simulation, Inventory Control Simulation using Monte Carlo Technique, Simulation of continuous and discrete processes with suitable examples from engineering problems

References:

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition. Academic press, 2000
2. Ogata K , “Modern control Engineering" 3 rd edition. Prentice hall of India 2001
3. Jang J.S.R. sun C.T and Mizutani E,, "Neuro-Fuzzy and soft Computing ", 3 rd edition, Prentice hall of India, 2002
4. Shannon, R. E., “System Simulation: the Art and Science”, Prentice Hall Inc. 1990
5. Pratab. R " Getting started with MATLAB" Oxford university Press 2009
6. Averill M Law and W D Kelton, “Simulation Modelling and analysis”, 3rd edition McGraw- Hill

Elective-III

MEMS and Microsystems

611503-C

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit -I: Over view of MEMS and Microsystems **(8)**

Definition, historical development, properties, design and fabrication micro-system, microelectronics, working principle, applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds, silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers.

Unit- II : Fabrication Processes **(8)**

:Photolithography, photo resist applications, light sources, ion implantation, diffusion Oxidation thermal oxidation, silicon dioxide, chemical vapour deposition, sputtering, deposition by epitaxy, etching, bulk and surface machining, LIGA process – LASER, Electron beam,Ion beam processes Mask less lithography

Unit -III: Micro Devices **(8)**

Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – measurands - displacement sensors, pressure sensor, flow sensors, Accelerometer , chemical and bio sensor - sensitivity, reliability and response of micro-sensor - micro actuators – applications.

Unit- IV: MEMS Accelerometers **(8)**

MEMS Accelerometers for Avionics, Piezoresistive Accelerometer Technology, MEMS Capacitive Accelerometer, MEMS Capacitive Accelerometer Process

UNIT-V: Microsystem Packaging **(8)**

Micro system packaging, packaging design levels of micro system packaging -Levels of packaging, interfaces in packaging – packaging technologies, Assembly of Microsystems

Packaging materials, Comparison between IC and MEMS packaging, Packaging technologies: Die preparation, surface bonding, wire bonding, sealing, Pressure sensor packaging

UNIT-VI:Bio-MEMS **(8)**

Introduction to Bio MEMS, Cell Electrophysiology, Silicon Micro-fabrication, Microfluidics and Bio-MEMS applications, MEMS for Drug delivery.

References:

1. Chang Liu, Foundations of MEMS, Prentice Hall (Pearson)
2. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi
3. Julian W. Gardner & Vijay K. Varadan, “Micro-sensors, MEMS and smart Devices”, John Wiley & Sons,.
4. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.
5. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997.
6. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN : 8493-9138-5
7. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003
8. Sami Franssila, Introduction to Micro fabrication, John Wiley & sons Ltd, 2004. ISBN:470-85106-6.

Elective-III

Mobile and Autonomous Robots

611503-D

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit I: Introduction to Mobile Robots **(8)**

Tasks of mobile robots, robot manufacturers, type of obstacles and challenges, tele-robotics, philosophy of robotics, service robotics, types of environment representation. Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots.

Unit II: Robot locomotion **(8)**

Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability
Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots

Unit III: Sensors for localization **(8)**

Magnetic and optic position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, GNSS and Sensors for navigation: tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual system .Current application and limitations of Mobile Robots.

Unit IV: Autonomous Robots **(8)**

The Basics of Autonomy (Motion, Vision and PID), Programming Complex Behaviors (reactive, deliberative, FSM), Robot Navigation (path planning), Robot Navigation (localization), Robot Navigation (mapping), Humanoid Robots and the DARPA challenge, Swarm Robotics, Telecheric robots, Robot Applications and Ethics.

Unit-V: Broad area Applications **(8)**

Automatic guidance, sowing, weeding, spraying and broad-acre harvesting, Horticulture: picking of fruits- Robot milking, sheep shearing, slaughtering, livestock inspection- Robots in construction, unsolved problems in construction, Future directions- Robots for hazardous applications, enabling technologies- Search and Rescue robotics: Disaster characteristics-Impact on Robots

Unit-VI: Medical robotics, Core concepts, Technology **(8)**

Medical robotic systems, Research areas and applications- Rehabilitation and Health care robotics: Overview, physical therapy and training Robots- Aids for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.
Cleaning Robots, lawn moving Robots- Smart appliances and smart homes- The role of Robots in education, Educational robotic platforms-. Robots and informal learning venues

References:

1. Bruno Siciliano, Oussama Khatib, ―Springer Handbook of Robotics‖, Springer-Verlag
2. Yangsheng Xu, Huihuan Qian, Xinyu Wu, "Household and Service Robots", Elsevier Ltd, 2015.
3. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011.
4. Aleksandar Lazinica, ―Mobile Robots towards New Applications, Advanced Robotic Systems International, 2006.
5. Gregory Dudek, Michael Jenkin, ―Computational Principles of Mobile Robotics‖, 2nd edition, Oxford University Press, 2010.
6. L Marques, A. de Almeida, Mo.Tokhi,G.S. Virk, ―Advances in Mobile Robotics, World Scientific Publishing Co. Pte. Ltd. 2008.

7. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, “Robotics – Control, Sensing, Vision and Intelligence”, McGraw Hill Int.
8. S.R. Deb, “Robotics Technology and Flexible Automation”, Tata McGraw Hill.
9. H. J. Warneck and R.D. Sehfart “Industrial Robots”, I.F.S. Pub., U. K.

Open Elective 3

Intellectual Property Rights

611503-E

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hrs/week	TH:4	In-sem-50 Marks
		End-sem-50 Marks

Unit-I: Introduction to IPR **(7)**

Introduction – Invention and Creativity – Intellectual Property (IP) – Importance –Protection of IPR – Basic types of property-Movable Property - Immovable Property and - Intellectual Property.

Unit-II: Patents and Copyrights **(7)**

IP – Patents – Copyrights and related rights – Trade Marks and rights arising from Trademark registration – Definitions – Industrial Designs and Integrated circuits – Protection of Geographical Indications at national and International levels – Application Procedures.

Unit-III: International Scenario **(7)**

International convention relating to Intellectual Property – Establishment of WIPO –Mission and Activities – History – General Agreement on Trade and Tariff (GATT) – TRIPS Agreement.

Unit-IV: National Intellectual Property Policy **(7)**

Indian Position Vs. WTO and Strategies – Indian IPR legislations – commitments to WTO-Patent Ordinance and the Bill – Draft of a national Intellectual Property Policy – Present against unfair competition.

Unit-V: Case Studies **(7)**

Case Studies on – Patents (Basmati rice, turmeric, Neem, etc.) – Copyright and related rights – Trade Marks – Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition.

Unit-VI: New Development in IPR **(7)**

New Developments in IPR, Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software, etc.

References:

1. Kankanala K. C., Narasani A. K. and Vinita Radhakrishnan V., "Indian Patent Law and Practice ", Oxford University Press, 2012, ISBN: 0198089600
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007, ISBN: 0415701279
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". ISBN: 9780735589131

Industry Internship-1/In-house research project-1

611504

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4hrs/week	PR:4	TW-50 Marks
		PR/OR-50 Marks

Conduction guidelines: The preferences/ choices of the domain will be taken from the students. The guide needs to be allocated based on the preference/ choices. The research project should be assigned to students. In case of Industry Internship-I, the assigned guide from college has to monitor and evaluate the progress of the student. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

Dissertation Stage I

611505

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 8hrs/week	PR:8	TW-50 Marks
		PR/OR-50 Marks

Dissertation Stage–I is an integral part of the Dissertation work. In this, the student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/ SRS/ UML/ ERD /block diagram/ PERT chart,) and Layout & Design of the Set-up. The student is expected to complete the dissertation at least up to the design phase. As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly approved and certified progress report of Dissertation Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/ Institute. The examiner will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report. The students are expected to validate their study undertaken by publishing it at standard platforms.
The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities at the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines circulated / as in the dissertation workbook approved by the Board of Studies.

Industry Internship-II/ In-house Research Project-II

611504

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hrs/week	PR:3	TW-50 Marks
		PR/OR-50 Marks

Conduction guidelines: Industry or research internship should include partial/ complete project implementation. Student should be allocated to the research guide in first semester itself and same guide should be continued for the: Industry Internship-II/ In house Research Project –II. Otherwise the preferences/ choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/ choices. The research project should be assigned to students. In case of Industry Internship-I, the assigned guide from college has to monitor and evaluate the progress of the student. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.

Dissertation Stage II

611505

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 18 hrs/week	PR:18	TW-150 Marks
		PR/OR-50 Marks

Guidelines:

In Dissertation Work Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of Selection of Technology, Installations, implementations, testing, results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/ known algorithms/ systems, comparative analysis, validation of results and conclusions. The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/ Institute. The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal. The student has to exhibit continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously.

Non-Credit Course 1:
Research Paper Writing
NCC1

Unit-I:
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit-II:
Clarifying Who did What, Highlighting your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a research Paper-Abstracts and Introduction.

Unit-III:
Sections of a research paper- Review of the Literature, Methods, Results, Discussion, Conclusions, Bibliography and References.

Unit-IV:
Key skills needed when writing a Title, when writing an Abstract, when writing an Introduction, when writing a Review of the Literature,

Unit-V:
Skills needed when writing the Methods, when writing the Results, when writing the Discussion, and Conclusions

Unit-VI:
How to write References, Submitting research paper for a journal, Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

References:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Non Credit Course 2:
Disaster Management
NCC2

Unit-I: Introduction
Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster;
Natural And Manmade Disasters: Difference, Nature, Types And Magnitude

Unit-II: Repercussions of Disasters and Hazards
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.
Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and
Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Unit-III: Disaster Prone Areas In India

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Unit-IV: Disaster Preparedness And Management
Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Unit-V: Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment And Warning, People's Participation In Risk Assessment. The strategies for Survival.

Unit-VI: Disaster Mitigation
Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation In India.

References:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep, et.al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration and Management: Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Non Credit Course 3:
Risk Management
NCC3

Unit 1 : Value-at-risk

Defining value at risk (VaR), calculating value at risk and expected shortfall when returns are normally distributed and not normally distributed, choice of parameters for value at risk, impact of autocorrelation on value at risk estimates, historical simulation approach, statistical tools for measuring value at risk. .

Unit II: Scope of Risk Management

Identification of risks, contingencies and associated potential costs, Analytical framework for detecting causes of risk resulting in financial loss, Selection of risk control strategies appropriate to the objectives of the business and implementation of such strategies, Monitoring and adapting to external and internal risk factors

Unit III: Volatility Modelling

Geometric Brownian motion Model, Poisson Jump Diffusion Model, ARCH/GARCH Models, Stochastic Volatility (SV) Models

References:

1. Christoffersen, P.F., "Elements of Financial Risk Management"', Academic Press, London, 2003
2. McNeil, Alexander, Rudiger Frey, and Paul Embrechts, "Quantitative Risk Management – Concepts, Techniques and Tools", Princeton UP, 2005
3. Hull John C., " Risk Management and Financial Institutions", 4th edition, Pearson, 2015

Non Credit Course 4:
Value Education
NCC4

Unit-I:
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

Unit-II:
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism.Love for nature, Discipline

Unit-III:
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking, Free from anger, Dignity of labour. Universal brotherhood and religious tolerance.True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

Unit-IV:
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation.Equality, Nonviolence,Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

References:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi
2. AICTE **Universal Human Value** course material

Non Credit Course 5:
Constitution of India
NCC5

Unit-I: History of Making of the Indian Constitution
History -Drafting Committee, (Composition & Working)

Unit-II: Philosophy of the Indian Constitution
Preamble Salient, Features

Unit-III: Contours of Constitutional Rights & Duties

Fundamental Rights ,Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit-IV: Organs of Governance

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Unit-V: Local Administration

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation. Panchayati raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Unit-VI: Election Commission

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Non Credit Course 6:
Pedagogy Studies
NCC6

Unit-I:
Pedagogy- Introduction and Methodology**,** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching

Unit-II:
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

Unit-III:

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

Unit-IV:

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment. Barriers to learning: limited resources and large class sizes.

Unit-V:

Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

References:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare,31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

Non Credit Course7:
Stress Management
NCC7

Unit-I:
Stress in Life, Stress-Models and Measurement, Managing stress, keeping stress at bay, Anxiety and stress, self help techniques

Unit-II:
Yoga for stress management- Definitions of the eight parts of yoga. (Ashtanga), Yam and Niyam. Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha, Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit-III:
Asan and Pranayam, Various yoga poses and their benefits for mind & body, Regularization of breathing techniques and its effects-Types of pranayama.

References:

1. Alok Chakrawal and Pratibha Goyal, "Stress Management", Studera Press, New Delhi
2. T.J. Powell and S.J. Enright, Änxiety and Stress management", Routledge, London
3. Yogic Asanas for Group Training-Part-I", Janardan Swami Yogabhyasi Mandal, Nagpur
4. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Non Credit Course 8:
Personality Development
NCC8

Unit I: Introduction to personality development

The concept personality, Dimensions of theories of Freud & Erickson, significance of personality development. The concept of success and failure, Hurdles in achieving success, Overcoming hurdles, SWOT analyses.

Unit II: Attitude & Motivation

Attitude: Concept, Significance, Factors affecting attitudes, Positive and negative Ways to develop positive attitude,

Motivation: Concept of motivation, Significance, Internal and external motives, Importance of self-motivation, Factors leading to de-motivation

Unit III: Self-esteem

Term self-esteem: Symptoms, Advantages - Do's and Don'ts to develop positive self-esteem. Low self-esteem: Symptoms, Personality having low self-esteem, Positive and negative self-esteem. Interpersonal Relationships: Defining the difference between aggressive, submissive and assertive behaviours - Lateral thinking.

Unit IV: Other aspects of personality development

Body language, Problem-solving, Conflict and Stress Management, Decision-making skills, Leadership and qualities of a successful leader, Character-building, Team-work, Time management, Work ethics, Good manners and etiquette.

References:

1. Bhatia R.C., "Personality Development", Ane Books Pvt Ltd, 2010
2. John Aurther, "Personality Development", Lotus Press, 2006
3. Dan P. McAdams, Rebecca L. Shiner, Jennifer L. Tackett, "Handbook of Personality Development", Guilford Publications, 2019

Non Credit Course 9:
Change Management
NCC9

Unit 1: Organizational Change Management

Understanding Organizational Transformation, Transformation Strategies, Process of Organizational Transformation, Nature of Organizational Change, Perspectives of Organizational Change, communicating changes, process of change management.

Unit II: Models of Organizational Change

Process-based Change Models, Content-based Change Models, Individual Change Models, Integration of Change Models

Unit III: Implementing Change:

Resistance to change, implementing change-the Delta Technique, Developing an Implementation Plan, Types of Change Management Strategies, Factors Affecting the Choice of a Change Strategy, Formulating and Facilitating Change, Facilitating Change,

Unit IV: Evaluating Organizational Change

Concept of Monitoring and Evaluation, Measurement and Methods of Evaluation, Feedback Process, Continuous Incremental Change, Maintaining organizational effectiveness: Approaches to Organizational Effectiveness, Perspectives of Organizational Effectiveness, Factors in Achieving Organizational Effectiveness

References:

1. James McCalman, Robert A Paton, Sabina Siebert, "Change Management: A Guide to Effective Implementation", SAGE Publication, 2015
2. Sharma R. R., "Change Management", Tata McGraw-Hill Education, 2006
3. John Hayes, "The Theory and Practice of Change Management", Macmillan Education UK, 2018

Non Credit Course 10:
Virtual Reality
NCC10

Unit-I: Introduction and Background

What VR is and why it is so different from other mediums. Its history and different forms of reality, ranging from the real world to fully immersive VR. Its various hardware and components, which composes those realities.

Unit-II: Perception

Understanding the human brain and how we perceive real and virtual worlds, real-world examples that prove reality is not always what we think it is, explanations of perceptual models and processes, the physiology of the different sensory modalities, theories of how we perceive space and time, and a discussion of how perception relates to action.

Unit-III: Designing in VR

Fundamentals of VR design including ergonomics, user testing, interface design, scale and scene setting, graphical user interfaces, and motion mechanics for mobile VR, simulator sickness, its causes.

Unit-IV: VR Platforms and Applications

Understand what is happening in the VR industry, surveying current trends and technology in VR, the hardware: Mobile Performance & 360 Media, High-Immersion Unity, or High Immersion Unreal

References:

1. Jason Jerald, The VR Book: Human-Centered Design for Virtual Reality, Association for Computing Machinery and Morgan & Claypool New York, NY, USA©2016, ISBN: 978-1-97000-112-9
2. John Vince, Virtual Reality Systems, Pearson Prentice Hall,
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, 2nd Edition, Wiley, ISBN: 978-0-471-36089-6