Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6312	**Industrial Automation**	**4-0-0**	**4**	**2019**

Course Objectives

1. To identify the managerial concepts behind industrial automation and to justify the need of industrial automation.
2. To identify the different hard ware components required for automation.
3. To identify the information technology components in automation.

Syllabus

Automation methodologies: Concepts-Types of Automation Trends in manufacturing-Flexible manufacturing systems-computer integrated manufacturing-Automated assembly systems.
CNC systems: CNC Mechanical systems, Material Handling Systems.
Group Technology and cellular manufacturing CAPP
Inspection automation: Inspection automation, CMMs, online inspection systems,
Communication systems for Automation- Computer networks and protocols, DFMA.

Expected Outcome

At the end of course, the student will be able to:
1. Understand the jjustification for automation
2. Understand the concept and types, degree and level of automation
3. Understand CNC, PLC, SCADA and various components of automation
4. Understanding transfer lines and advanced industrial automation
5. To model and simulate plant automation

References

1. Yoram Koren, Computer Control of Manufacturing Systems, Tata McGraw Hill, 2005.
2. M.P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education, 5th Edition, 2009.
3. W.Bolton, Mechatronics: A Multidisciplinary Approach,4th Edition, Pearson Education India
4. Radhakrishnan P, CNC Machines, New Central Book Agency, 1992.
5. Mechatronics, HMT, Tata McGraw-Hill,1998.
6. Krishna Kant, Computer Based Industrial Control, EEE-PHI,2nd Edition, 2010
7. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, Product Design for Manufacture and Assembly (Manufacturing Engineering and Materials Processing), 3rd Edition, CRC Press.
8. D.M. Considine, G.D. Considine, Standard Handbook of Industrial Automation, Chapman and Hall, New York, 1986.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Automation in Production System: Principles and Strategies of Automation, Basic Elements of an Automated System, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.	**9**	**15 %**
II	**Material handling and Identification Technologies**: Material handling, Introduction, material handling systems, principles and design, material transport system: transfer mechanisms automated feed cut of components, performance analysis, uses of various types of handling systems including AGV and its various guiding technologies. Storage system, Performance, location strategies, conventional storage methods and equipments, automated storage systems.	**9**	**15 %**
First Internal Examination			
III	**Automated Manufacturing Systems:** Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, CIM, transfer lines and fundamentals of automated production lines, application, analysis of transfer line without internal storage. **Quality Control Systems:** Traditional and Modern Quality Control Methods, Inspection Principles and Practices, Design for Manufacture, Assembly and Automation. Poka Yoke principles, contact and non-contact conventional measuring, gauging technique, CMM, surface measurement, machine vision, other optical inspection techniques, non-contact non-optical inspection technologies versus.	**9**	**15 %**
IV	**Control technologies in automation:** Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms, Computer Based Industrial Control: Introduction & Automatic Process Control. **Numerical control:** concepts- evolution-CNC-Structure of CNC machines, components, ball screws and guideways, Spindle, bearings and mountings. Drive systems. Automated tool changers and pallet changers. Accessories.	**9**	**15 %**
Second Internal Examination			
V	**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. Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADA Systems &RTU. Distributed Control Systems, Functional Requirements, Configurations	**10**	**20 %**
VI	Modeling and Simulation for Plant Automation: Introduction, need for system modeling, Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement, Thermal Water Treatment & Steel Plants.	**10**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6322	**Programmable Logic Control and Computer Numerical Control**	**3-0-0**	**3**	**2019**

Course Objectives

The objective of this course is to provide a thorough understanding about Programmable Logic Control and Computer Numerical Control.

Syllabus

Introduction to Logic Circuits, Programmable Logic Controller Architecture, PLC programming methods, Ladder Programming, Programming Style, Communication links for PLC, Fundamentals of Numerical Control, Classification, Features of NC machine tools, Interpolation, Control loops for CNC, Manual part programming, Computer aided programming, APT programming, Direct Numerical Control, Distributive numerical control.

Expected Outcome

On completion of the course, the students will have acquired knowledge and skills in using PLCs, Ladder programming, CNC machines, Manual part programming and Computer Aided Programming.

References

1. Enrique Mandado, Jorge Marcos,Serafin Peres, Programmable Logic Devices and Logic Controllers, Prentice Hall, 1996.
2. Gray Dunning, Delamar, Introduction to Programmable Logic Controllers, Thomson Learning, 1998.
3. E.A. Parr, Programmable Controllers- An Engineers's Guide, 2nd Edition, Newnes, 1999.
4. George L. Atten Jr., Programmable controllers, Hardware, Software & Applications,Mc Graw Hill, 2nd Edition, 1994.
5. KorenY., *Computer Control of Manufacturing Systems,* McGraw Hill,1983.
6. Devdas Shetty, Richard A Kolk, Mechatronics System Design, PWS Publishing Company.
7. Mechatronics- HMT Ltd. Tata McGraw Hill, 2011
8. Bolton, Mechatronics- Electronic control systems in mechanical and electrical engineering, Pearson, 6th Edition, 2015.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Introduction to logic circuits, Logic Controllers- Combinational and Sequential Logic Controllers- Synchronous and synchronous logic controllers- Design examples- Non modular, Modular and Semi-modular logic controllers.	**6**	**15 %**
II	Programmable Logic Controllers- Basic PLC with Load and Store operations, PLC with Conditional Instructions- Input and Output modules- Discrete AC/DC and Analog Input/Output- Modular PLC- Relays for Logic Control- Relay Diagrams- PLC programming Methods- IEC 1133-3 standard- Ladder programming	**8**	**15 %**
First Internal Examination			
III	Program and Data Organization in PLC- Basic relay instructions- Timers and Counters- Comparison and data handling- Sequencer instructions. Programming Style- Top Down design- Proprietary and Standard communication links for PLC- PROFIBUS.	**7**	**15 %**
IV	Fundamentals of numerical control- advantages of NC systems- classification of NC systems- point to point and contouring systems- NC and CNC- incremental and absolute systems open loop and closed loop systems- features of NC machine tools- fundamentals of machining. Introduction to Modern CNC Machines- Advantages of CNC Machines.	**7**	**15 %**
Second Internal Examination			
V	Interpolation- linear interpolator- circular interpolators Complete interpolator- Control Loops for CNC- CNC software interpolator. Manual part programming examples- point to point programming and simple contour programming, canned cycles.	**7**	**20 %**
VI	Computer aided programming- concepts- APT programming- part programming examples, Geometric definitions- cutter motion definitions-postprocessor statements-generation and execution of APT programs. Direct Numerical Control (DNC), Distributive Numerical control, DNC software.	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6332	**Control, Programming and Calibration of Robots**	**3-0-0**	**3**	**2019**

Course Objectives

- To familiarize students with different control schemes for robots
- To acquaint the students with programming of robots
- To familiarize students with calibration of robots

Syllabus

Control of Robots in task space, Passivity based control, Compliant motion control, Hybrid position and force control, Control of mobile robots and quadcopters to track different trajectories, Vision based Control- Position based visual servoing, Image based visual servoing, Hybrid visual servoing. Programming of robots using, RAPID, ROS. Fundamental algorithms in MATLAB for modelling and control of robots. Robot calibration methods.

Expected Outcome

Upon successful completion of this course, students will be able to:

1. Design controllers for robotic manipulator in task space
2. Develop hybrid position and force controllers
3. Develop vision based controllers
4. Program robots using RAPID & ROS
5. Implement trajectory tracking controllers for mobile robots and quadcopters
6. Path planning and localization of UGV's
7. Calibrate robotic manipulators for a particular application

References

1. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Robotics: Modelling, Planning and Control, Springer, 2008.
2. S R Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, 2005.
3. Wisama Khalil, Etienne Dombre, Modeling, Identification and Control of Robots, Taylor & Francis, 2002.
4. Peter Corke, Robotics, Vision and Control- Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, Vol. 73.
5. Z. S Roth, B W Mooring, B Ravani, An overview of Robot Calibration, IEEE Journal of Robotics and Automation, 1987.
6. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, Apress, 2018

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Control of robotic manipulators in task space- PID Control and Computed torque control, Passivity based position control and tracking control, compliant motion control, Hybrid position and force control, Nonlinear Control- PD gravity control, Computed torque control, Variable Structure control, Impedance control. Resolved rate motion control. Selection of motors for robotic manipulators & AGVs, Control of different electric drives- DC Motor, servo motor, stepper motor, BLDC motor. Implementation of PID controller.	**8**	**15 %**
II	Kinematic model of steered robot and differentially driven mobile robot, Control of a mobile robot to move to a point, to follow a line, following a path, moving to a pose, Dynamic model of quadcopter- Controller design to track any desired trajectory.	**6**	**15 %**
First Internal Examination			
III	Sensors in Robotics- status sensors, environment sensors, quality control sensors, safety sensors etc. Robot vision- Image representation, Perspective and inverse perspective transformations. Vision based Control- configuration of a vision system, image segmentation, image interpretation, Pose estimation, Stereo vision, Camera Calibration, Position based visual servoing, Image based visual servoing, Hybrid visual servoing.	**7**	**15 %**
IV	Robot Programming- classification of robot languages, teach in and Offline programming, RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode. Robot Studio- Create a mechanism, auto path control, collision control, reachability, editing and debugging, Introduction to ROS and simple programming examples.	**7**	**15 %**
Second Internal Examination			
V	Fundamental algorithms in MATLAB- for trajectory generation- one dimensional and multidimensional case, trajectory tracking, Navigation-reactive navigation, Map based planning, Localization- Dead reckoning, Monte-Carlo Localization, Kinematic & Dynamic modeling, Control of robots.	**7**	**20 %**
VI	Robot Calibration methods- level 1, 2, 3 calibration with model, measurement, identification and correction, Manual Calibration, Bulls eye- calibration of Tool Centre Point, Calibration by Force Control, Laser based Calibration, Absolute accuracy, PosEye, Calibration of work object co-ordinate system.	**7**	**20 %**
End Semester Examination			

ELECTIVE-II

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6342(A)	Artificial Intelligence and Expert Systems in Automation	3-0-0	3	2019

Course Objectives

The objective of this course is to introduce to the master students the basic ideas of Artificial Intelligence and Expert Systems in Automation. The course explains the applications of AI, select search strategies based on application requirement, knowledge representation methods and discuss architecture of expert systems. It also gives application of on-line search agent for purchase application.The course provides a strong background on these areas which, besides being important for their applications, will also be essential for higher studies and research in engineering.

Syllabus

Artificial Intelligence, Intelligent Agents, Problem-solving, Beyond Classical Search, Knowledge Representation, Uncertain knowledge and reasoning and Probabilistic Reasoning over time

Expected Outcome

After the successful completion of this course, the student will be able to:

1. Describe and explain the applications of AI, select search strategies based on application requirement.
2. Explain knowledge representation methods, discuss architecture of expert systems.
3. Application of on-line search agent for purchase application.

References

Text Books:

1. Stuart Russell, Peter Nowig, Artificial Intelligence: A Modern Approach, 3rd Edition, Pearson.
2. Donald A Waterman, A Guide to Expert Systems, Addison Wesley, 2nd Edition, 1986.

Reference Books:

1. Dan W Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI, 2nd Edition, 2009.
2. George. F. Luger, Artificial Intelligence, 3rd Edition, Pearson Education, 2009.
3. Robert J. Schalkeff, Artificial Intelligence: An Engineering Approach, PHI, 2nd Edition, 1990.

	COURSE PLAN		
Module	**Course Description**	**Hours**	**Marks for Semester Exams**
I	**Artificial Intelligence**: The Foundations of Artificial Intelligence, The History of Artificial Intelligence. **Intelligent Agents**: Agents and Environments, the Concept of Rationality, the Nature of Environments, the Structure of Agents.	**6**	**15%**
II	**Problem-solving:** Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search. Informed (Heuristic) Search Strategies, Greedy best-first search, A* search, Heuristic Functions, The effect of heuristic accuracy on performance.	**8**	**15%**
	First Internal Examination		
III	**Beyond Classical Search:** Local Search Algorithms and Optimization Problems, Hill-climbing search, Simulated annealing, Local beam search, Genetic algorithms, Local Search in Continuous Spaces, Searching with Nondeterministic Actions, Searching with Partial Observations, Online Search Agents and Unknown Environments.	**7**	**15%**
IV	**Knowledge Representation:** Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Semantic networks, Description logics, Reasoning with Default Information, Truth maintenance systems.	**6**	**15%**
	Second Internal Examination		
V	**Uncertain knowledge and reasoning:** Quantifying Uncertainty, Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Bayes' Rule and Its Use, Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, and Inference by Markov chain simulation, Relational and First-Order Probability Models.	**8**	**20%**
VI	**Probabilistic Reasoning over Time:** Time and Uncertainty, Inference in Temporal Models, Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks, Keeping Track of Many Objects, Combining Beliefs and Desires under Uncertainty, The Basis of Utility Theory, Utility Functions, Multi-attribute Utility Functions, Decision Networks, The Value of Information. Expert system architecture.	**7**	**20%**
	End Semester Examination		

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6342(B)	**Robotics Based Industrial Automation**	**3-0-0**	**3**	**2019**

Course Objectives

1. To know about the basic concepts in industrial automation.
2. To design automated systems.
3. To know about transfer lines and automated assembly.
4. To know about automated Inspection principles and methods.

Syllabus

Automation principles and strategies, Automated Flow lines, transfer mechanism, Automation for machining, materials handling, assembly and inspection, Sensor Technologies for Automated Inspection, Simulation Models and Analytical Models.

Expected Outcome

After the successful completion of this course, the student will be able:
1. To identify potential areas for automation and justify need for automation
2. Classify various types of automated transmission lines and components of automation.
3. To identify suitable automation hardware for automation and inspection.
4. List and understand various material handling systems.
5. Design various types of automated assembly systems
6. Explain various automatic inspection systems

Text Books:

1. Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia, 2001.
2. C. Ray Asfahl, Robots and manufacturing Automation, John Wiley and Sons New York, 1992.

Reference Books:

1. N.Viswanadham, Y.Narahari, Performance Modeling of Automated Manufacturing Systems, Prentice Hall India Pvt. Ltd, 1992.
2. Stephen J. Derby, Design of Automatic Machinery, Marcel Decker, New York, 2004.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Introduction: 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,	**7**	**15 %**
II	Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines without Storage, Partial Automation, Automated Flow Lines with Storage Buffers	**6**	**15 %**
First Internal Examination			
III	**Assembly Systems and Line Balancing:** The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods, Other ways to improve the Line Balancing, Flexible Manual Assembly Lines. Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Vibratory bowl feeder and Non vibratory bowl feeder, Part Orienting Systems, Feed tracks, Escapements and part placing mechanism, Analysis of Multi-station Assembly Machines, Analysis of a Single Station, Assembly Machine.	**8**	**15 %**
IV	**Automated Materials Handling:** The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems.	**6**	**15 %**
Second Internal Examination			
V	**Automated Storage Systems:** Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing.	**8**	**20 %**
VI	**Automated Inspection and Testing:** Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods, Modeling Automated Manufacturing Systems: Role of Performance Modeling, Performance Measures, Performance Modeling Tools: Simulation Models, Analytical Models.	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6342(C)	**Digital System Design**	**3-0-0**	**3**	**2019**

Course Objectives

The objective of the course is:
1. To learn advanced digital design concepts.
2. To design digital sub-systems using Verilog HDL.
3. To learn Memory, CPLDs, FPGAs and ASICs.

Syllabus

Basic Digital systems, Hardware Description Language, Specification of combinational systems using VHDL, Introduction to VHDL, Design of RTL Systems, Programmable Logic Devices, IP and Prototyping.

Expected Outcome

Upon completion of this course students would be able to:
1. Design digital circuits and subsystems using Verilog HDL.
2. Have basic understanding of Memory, CPLDs, FPGAs and ASICs.

Text Books:
1. V.Padroni, Digital System Design, Pearson.
2. M. Ercegovac, T. Lang and L.J. Moreno, Introduction to Digital Systems, Wiley,2000

Reference Books:
1. C. H. Roth, Digital System Design using VHDL, Jaico Publishing, 2001
2. J. Bhaskar, A VHDL Primer, Addison Wesley, 1999.
3. Douglas L. Perry, VHDL Programming by Examples, TMH, 2000
4. Sumit Ghose, Hardware Description Languages, PHI, 2000
5. P.J. Ashendern, The Designer Guide to VHDL, Kaufmann Pub. 2000
6. Mark Zwolinski, Digital System Design with VHDL, Prentice Hall Pub. 1999
7. Zeidman, Designing with FPGA & CPLDs, CMP Pub. 1999
8. Douglas J. Smith, HDL Chip Design, Doone Pub. 2001

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Review of basic Digital systems: Combinational Circuits, Sequential Circuits, Logic families. Synchronous FSM and asynchronous design, Metastability, Clock distribution and issues, basic building blocks like PWM module, pre-fetch unit, programmable counter, FIFO, Booth's multiplier, ALU, Barrel shifter etc.	**7**	**15 %**
II	Gajski's 'Y' Chart, Behavioral Modeling, Data flow modeling, Structural modeling, Hardware Description Language, Specification of combinational systems using VHDL, Introduction to VHDL, Basic language, element of VHDL, Design of Adder, Subtractor, Decoder, Encoder, and Multiplexor circuit, Generic, Component and Package description with example.	**7**	**15 %**
First Internal Examination			
III	Description and design of sequential circuits using VHDL, Description of Process, Functions, Packages and loop statement using example, Design of shift Register, Design of Counter and Memory using VHDL.	**7**	**15 %**
IV	Register- transfer level systems, Systems, Analysis of RTL Systems, Design of RTL Systems. Data Subsystems, Storage Modules, Functional Modules, Data paths, Control Subsystems. Basics of State Machine, Design of a Serial Adder with Accumulator, State Graph for Control Network, design of a Binary Multiplier.	**7**	**15 %**
Second Internal Examination			
V	ProgrammableLogicDevices:Introduction,Evolution:PROM,PLA,PAL,Architectureof PAL's, Applications, Programming PLD's, FPGA with technology: Antifuse, SRAM, EPROM, MUX,FPGA structures, and ASIC Design Flows, Programmable Interconnections, Coarse grained reconfigurable devices	**7**	**20 %**
VI	**IP and Prototyping: IP in various forms:** RTL Sourcecode, Encrypted Sourcecode, Soft IP, Netlist, Physical IP and Use of external hard IP during prototyping, Case studies, and Speed issues. Testing of logic circuits: Fault models, BIST, JTAG interface	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6342(D)	**Sensors, Microprocessors, Microcontrollers and their Applications**	**3-0-0**	**3**	**2019**

Course Objectives

1. To understand different types of sensors and their applications
1. To expose the students to the fundamentals of microprocessor architecture.
2. To introduce the advanced features in microprocessors and microcontrollers.
3. To enable the students to understand various microcontroller architectures.

Syllabus

Advanced sensor technologies and applications in flexible manufacturing systems, networking of sensors, advanced sensors and their application, microprocessors and microcontrollers

Expected Outcome

The student will be able to:
1. Understand different types of sensors, their characteristics and applications
2. Work with suitable microprocessor / microcontroller for a specific real world application

Textbooks:

1. Sabnesoloman, Sensors & control systems in manufacturing.Mc-Graw Hill, 1994.
2. W. Bolton, Mechatronics.
3. D V Hall, Microprocessor and Its Applications, TMH.
4.B.B. Bray, The Intel Microprocessors 8086/8088,80186/80188,80286,80386,80486, Pentium and Pentium Pro processor, architecture, programming and interfacing, PHI India.
5.Mohammed Refiguzzaman, Microprocessor & Microcomputer Based System Design, Universal Books Stall, New Delhi.
6.Ajay V. Deshmukh, Micro-controllers Theory and Applications, Tata McGraw Hill, 2005.

References:

1. Jon S. Wilson, Sensor Technology Handbook,
2. N.L. Buck, T.G.Buckwith, Mechanical measurement.
3. Ian Sinclair, Sensors and Transducers.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	**Fundamentals of Sensors and Transducers:** Performance, terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter. Sensors and their applications: Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors.	**7**	**15 %**
II	Advanced Sensor Technologies: Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID(Radio Frequency Identification), electromagnetic identifier, optical encoders, color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor fuzzy logic for optoelectronic colour sensor in manufacturing. Sensors in Flexible Manufacturing Systems: Vision sensors, image transformations, robot visual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing.	**7**	**15 %**
First Internal Examination			
III	**Networking:** Networking of sensors, control of manufacturing process, tracking-the mean time between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.	**7**	**15 %**
IV	**Sensors for Special Applications:** A multi objective approach for selection of sensors in manufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photo luminescence temperature detectors using point contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.	**7**	**15 %**
Second Internal Examination			
V	**Microprocessors:** Evolution of Microprocessors, General architecture of μP, an overview of 8086/88/ architecture minimum/maximum mode configuration. Assembly Language programming in 8086, interrupt structure Programmed I/O, parallel I/O (8255-PPI) serial I/O (8251/8250), RS-232, IEEE bus standard, 8157DMA controller A/D&D/A conversion, 8253/54 PIT/counters, 8087 Numerical processor and its interfacing with 8086.	**7**	**20 %**
VI	**Microcontrollers:** Introduction to 8051 micro-controller family: Pin description of 8051 and its internal structure, connections of I/O ports and Memory organization Addressing mode. Instruction set & its format and simple programs. Atmel micro-controller 89C51 and 89C2051. Introduction to 8096/8097 family and essential difference with 8051. Applications of microprocessors and micro-controller	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6342(E)	**Intelligent Visual Surveillance Systems**	**3-0-0**	**3**	**2019**

Course Objectives

1. To understand the basics of image processing and video compression standards
2. To understand object detection and tracking
3. To understand tracking of objects, multiple objects and multiple interacting objects, camera placement and calibration
4. To know the technique of human activity recognition, gait recognition etc.

Syllabus

Basics of Image Processing, Image Processing methods, Image Transforms, Wavelet Transform, JPEG Image Compression, Image Formats, Color Spaces- RGB, CMY, HIS, Video Compression Standards, Object Detection and Classification, Multi-Object Tracking, Particle filter based object tracking, Mean Shift based tracking, Tracking of multiple interacting objects, Human Activity Recognition, Camera Network Calibration

Expected Outcome

The student will be able to:
1. Understand different types of image processing and video compression standard
2. Understand different methods of object detection, tracking and human activity recognition
3. To understand camera placement and calibration.

Text Books:

1. Murat A. Tekalp, Digital Video Processing, Prentice Hall, 1995.
2. Y. Ma, G. Qian (Eds.), Intelligent Video Surveillance: Systems and Technology, CRC Press, 2009.

COURSE PLAN			
Module	**Course description**	**Hours**	**Marks for Semester Exams**
I	Basics of Image Processing: Introduction to Image Processing methods, Image Transforms, Wavelet Transform, JPEG Image Compression, Image Formats, Color Spaces- RGB, CMY, HSI.	**7**	**15%**
II	Video Compression Standards: H. 261, H. 263, H.264, MPEG-1, MPEG-2, MPEG-4, MPEG-7, and MPEG-21, Video shot boundary detection, motion modeling and segmentation techniques.	**7**	**15%**
	First Internal Examination		
III	**Object Detection and Classification:** Shape based object classification, motion based object classification, Silhouette-Based Method for Object Classification, Viola Jones object detection framework, Multi-class classifier boosting.	**7**	**15%**
IV	**Multi-Object Tracking:** Classification of multiple interacting objects from video, Region-based Tracking, Contour-based Tracking, Feature-based Tracking, Model-based Tracking, Hybrid Tracking, Particle filter based object tracking, Mean Shift based tracking, Tracking of multiple interacting objects.	**7**	**15%**
	Second Internal Examination		
V	**Human Activity Recognition:** Template based activity recognition, Sequential recognition approaches using state models (Hidden Markov Models), Human Recognition Using Gait, HMM Framework for Gait Recognition, Description based approaches, Human interactions, group activities, Applications and challenges.	**7**	**20%**
VI	**CCTV (closed circuit television):** Camera Network Calibration- Types of CCTV camera- PTZ (pan-tilt zoom) camera, IR (Infrared) camera, IP (Internet Protocol) camera, wireless security camera, Multiple view geometry, camera network calibration, PTZ camera calibration, camera placement, smart imagers and smart cameras.	**7**	**20%**
	End Semester Examination		

ELECTIVE-III

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6352(A)	**Design of Embedded Systems**	**3-0-0**	**3**	**2019**

Course Objectives

1. To explore the concepts of embedded system design
2. To Study about embedded system design and its analysis
3. To Study about software development tools

Syllabus

Characteristics of embedded computing applications, design process, Embedded Computing Platform CPU bus-memory devices-I/O device, Program Design and Analysis, basic compilation techniques, design methodologies, Introduction to assembler, compiler, cross-compiler, linker and integrated development environment debugging strategies-simulators-emulators-logic analyzers.

Expected Outcome

1. Understand the concepts of embedded system design
2. Understand software development tools
3. Understand, Analyze embedded system design and its applications

References

1. Wayne Wolf, Computers as Components-Principles of Embedded Computing System
2. Design, Morgan Kaufman Publishers, 2008.
3. David E. Simon, An Embedded Software Primer, Pearson Education, 2004.
4. Frank Vahid, Tony Givargi, Embedded System Design: A Unified Hardware/Software
5. Introduction, John Wiley & Sons, 2001.
6. Steve Heath, Embedded System Design, Elsevier science, 2003.
7. Arnold S. Berger, Embedded System Design: An Introduction to Processors

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Introduction-characteristics of embedded computing applications-challenges in embedded computing design-design process: requirements-specification-architecture design-designing hardware and software components-system integration and testing- structural description behavioral description.	**7**	**15 %**
II	The Embedded Computing Platform CPU bus-memory devices- I/O devices-component interfacing-development and debugging-testing-design examples- alarm clock.	**7**	**15 %**
First Internal Examination			
III	Program Design and Analysis Introduction-design patterns-data flow graph-control /data flow graphs-assembly and linking.	**7**	**15 %**
IV	Basic compilation techniques-analysis and optimization of execution time, energy, power and program size program validation and testing-design examples: software modem.	**7**	**15 %**
Second Internal Examination			
V	System Design Techniques Introduction- design methodologies-requirement analysis- specifications- system analysis and architecture design-quality assurance.	**7**	**20%**
VI	Software Development and Tools, Introduction to assembler, compiler, cross-compiler, linker and integrated development environment debugging strategies-simulators- emulators-logic analysers: introduction to JTAG.	**7**	**20%**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6352(B)	**Advanced Robotics**	**3-0-0**	**3**	**2019**

Course Objectives

1. To introduce the basic concepts, parts of robots and types of robots.
2. To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
3. To discuss about the various applications of robots, justification and implementation of robot

Syllabus

- Introduction and classification of robots
- Robot kinematics and dynamics
- Robot drives and power transmission systems
- Robot end effectors Path planning & programming
- Robot Language- Software- Industrial application

Expected Outcome

At the end of the course the students will:

1. The Student must be able to design automatic manufacturing cells with robotic control.
2. The student could understand the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

References

1. Deb S. R, Deb S., Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010.
2. John J. Craig, Introduction to Robotics, Pearson, 2009.
3. Mikell P. Groover, Industrial Robots- Technology, Programming and Applications, McGraw Hill, New York, 2008.
4. Richard D Klafter, Thomas A Chmielewski, Michael Negin, Robotics Engineering- An Integrated Approach, Eastern Economy Edition, Prentice Hall of India, 2006.
5. Fu K S, Gonzalez R C, Lee C.S.G, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1987/

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Specifications and Classifications of robots- Work envelope, Flexible automation versus Robotic technology- Applications of Robots	**7**	**15 %**
II	**Robot kinematics and dynamics**: Positions, Orientations and frames, Mappings: Changing descriptions from frame to frame, Operators: Translations, Rotations and Transformations- Transformation Arithmetic- D-H Representation- Forward and inverse Kinematics of Six Degree of Freedom Robot Arm- Robot Arm dynamics	**7**	**15 %**
First Internal Examination			
III	**Robot drives and power transmission systems:** Robot drive mechanisms, hydraulic- electric- servomotor- stepper motor Pneumatic drives, Mechanical transmission method- Gear transmission, Belt drives, cables, Roller chains, Link- Rod systems Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws	**7**	**15 %**
IV	**Robot end effectors:** Classification of End effectors- Tools as end effectors. Drive system for grippers-Mechanical adhesive-vacuum-magnetic grippers. Hooks &scoops. Gripper force analysis and gripper design. Active and passive grippers, Sensors, distance sensors, ultrasound distance sensors, IR proximity sensors, optical, triangulating and laser sensors, linear sensors.	**7**	**15 %**
Second Internal Examination			
V	**Robot control:** Error dynamics, motion control with velocity input, torque input and force input, force control, hybrid motion force control, impedance control, On-off control, PD, PID control, velocity, position control	**7**	**20 %**
VI	**Robot languages:** computer control and Robot software, Industrial Application of robots, humanoid robots, intelligent control systems, flexible manipulators, mechanism theory, microsensors and actuators, and compliant mechanism, Biped Locomotion, Exoskeleton, Intelligent control systems, Micro Sensors and Actuators	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6352(C)	**Adaptive Control**	**3-0-0**	**3**	**2019**

Course Objectives

1. Inculcate conceptual understanding of adaptive control
2. Provide knowledge on various adaptive schemes, with a basic understanding on closed loop system stability and implementation issues
3. Develop ability to design suitable stable adaptive scheme to meet the performance objectives even in the presence of disturbances and changing operating conditions
4. Design model reference adaptive control system considering matched structured uncertainties
5. Identify the need and apply appropriate adaptive control design technique to real-time systems

Syllabus

Adaptive Control, Adaptive Schemes, Adaptive Control Problem; Applications, Regression Models, Recursive Least Squares, Real-Time Parameter Estimation, Direct and Indirect Self-Tuning Regulators Pole Placement Design, MDPP, Model Reference Adaptive Systems, MIT Rule, Design of MRAS Using Lyapunov Theory, Relations between MRAS and STR, Adaptive Feedback Linearization, Adaptive Back Stepping, Gain Scheduling, Design of Gain-Scheduling Controllers, Nonlinear Transformations. Practical Issues and Implementation, Operational Issues, Case Study.

Expected Outcome

At the end of the course the students will:

1. Formulate adaptive control design problem
2. Identify suitable adaptive controller for a given system with uncertain parameters
3. Apply adaptive design techniques to real-time systems whose parameters change during operation.
4. Implement adaptive control schemes to meet the performance objectives in challenging situations.

References

1. Karl Johan Astrom, Bjom Wittenmark, Adaptive Control, Addison Wesley, 2003.
2. Shankar Sastry, Adaptive Control, PHI, 1989.
3. Karl Johan Astrom, Adaptive Control, Pearson Education, 2001.
4. Petros A Loannou, Jing, Robust Adaptive Control, Prentice-Hall, 1995.
5. Eykhoff P, System Identification: Parameter and State Estimation, 1974.
6. Ljung, System Identification Theory for the User, Prentice-Hall, 1987.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Introduction: Adaptive Control, effects of process variation- Adaptive Schemes- Adaptive Control problem- Applications- Real Time Parameter Estimation: Introduction- Regression Models- Recursive Least Squares- Exponential Forgetting- Estimating Parameters in Dynamical Systems- Experimental Conditions- Loss of identifiability due to feedback	**7**	**15 %**
II	Deterministic Self-Tuning Regulators: Introduction- Pole Placement Design, MDPP- Design of Indirect Self-tuning Regulators- Continuous Time Self-tuners- Direct Self-tuning Regulators- Properties of Direct Self-tuners- Disturbances with Known Characteristics, Case Study	**7**	**15 %**
First Internal Examination			
III	Model Reference Adaptive Systems: Introduction- MIT Rule- Significance of Adaptation Gain- Lyapunov Stability Theory- Design of MRAS Using Lyapunov Theory- Adaptation of a Feedforward Gain- Applications to Adaptive Control, Case Study	**7**	**15 %**
IV	Relations between MRAS and STR- Nonlinear Systems- Feedback Linearization- Adaptive Feedback Linearization- Back Stepping- Adaptive Back Stepping, Case Study	**7**	**15 %**
Second Internal Examination			
V	Gain Scheduling: Introduction- Principle- Design of Gain Scheduling controllers- Nonlinear Transformations- Applications of Gain Scheduling, Case Study	**7**	**20 %**
VI	Practical Issues and Implementation- Controller Implementation- Computational Delay- Sampling and Pre- and Post Filtering- Controller Windup- Estimator Implementation- Operational Issues	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6352(D)	**Non-linear and Adaptive Control systems**	**3-0-0**	**3**	**2019**

Course Objectives

1. To study the characteristics of a non-linear system and different types of non-linearities in a system.
2. Should be able to analyze a Non-linear system.
3. Should be able to analyze an adaptive control system with different configurations

Syllabus

Features and Characteristics of non-linear systems- Common non-linearities, Describing function Analysis, Phase plane analysis- Singular points, Construction of Phase portraits, Stability analysis of Nonlinear systems, Liapunov stability analysis, Popov's stability criterion, Circle criterion, Variable structure control systems- Sliding mode control, Development of adaptive control problem, Model Reference Adaptive Systems, Adaptive predictive control. Back stepping

Expected Outcome

At the end of the course the students will:

1. Understand more details about different nonlinearities present in a system.
2. Understand different methods used for analysing a Nonlinear system.
3. Understand more about an adaptive control system schemes

References

1. Jean-Jacques Slotine, Weiping Li, Applied Nonlinear Control, Prentice Hall.
2. Shankar Sastry, Nonlinear System Analysis, Stability and Control, Springer.
3. Hassan K Khalil, Nonlinear systems, Macmillan

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Features of linear and non-linear systems- Common non-linearities Characteristics of Nonlinear systems- Limit cycles- stability, jump resonance- Describing function Analysis- Describing function of different non linearities- saturation, dead zone, relay, hysteresis	**7**	**15 %**
II	Phase plane analysis- Singular points- types- Construction of Phase portrits- Isocline, Delta methods.	**7**	**15 %**
First Internal Examination			
III	Stability analysis of Nonlinear systems, Liapunov stability analysis Construction of Liapunov function- variable gradient method	**7**	**15 %**
IV	Popov's stability criterion, Circle criterion, Variable structure control systems-basic concepts- Sliding mode control.	**7**	**15 %**
Second Internal Examination			
V	Introduction- Development of adaptive control problem- The role of Index performance(IP) in adaptive systems- Gain scheduling- Model Reference Adaptive Systems- The MIT rule.	**7**	**20 %**
VI	Self tuning regulators- Adaptive predictive control. Determination of Adaptation gain Backstepping approach to Stabilization.	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6352(E)	**Computer Aided Modelling and Design**	**3-0-0**	**3**	**2019**

Course Objectives

The general objectives of the course are to enable the students to
1. Understand the generation of geometrical primitives in a graphics system.
2. Learn principles of geometrical modelling of curves and surfaces.
3. Learn CAD data formats in practice and practical applications.

Syllabus

Solid Modelling: Representation of Solids, Topology, Wireframe, Boundary representation (B-Rep), CSG, Analytic curves, Synthetic curves-Bezier, B-Spline, NURBS, Graphics standards: GKS IGES, PDES, surface modeling, computer graphics- OPenGL, meshing data structures, advanced modeling techniques, Computer Aided Design of mechanical parts and Interference Detection by Motion analysis.

Expected Outcome

At the end of the course, the student shall be able to understand:
1. To study transformation matrix for 2D and 3D transformation
2. To analyse various splines and curves
3. To define the solid modeling, data exchange formats.
4. To understand the analysis of mechanical assembly

Text Books:

1. Ibrahim Zeid, CAD/CAM, Theory and Practice, McGraw Hill, 1998.
2. Foley, Van Dam, Feiner, Hughes, Computer Graphics Principles and Practice, Addison-Wesley, 2000.

Reference Books:

1. Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995.
2. Hill Jr, F.S., Computer Graphics using open GL, Pearson Education, 2003.
3. Hearn & Baker, Computer Graphics, PHI.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**Marks for Semester Exams**
I	Solid Modeling: Representation of Solids, Topology, Wireframe, Boundary representation (B-Rep), CSG, Solid modeling operations, 2D & 3D Geometric Transformations: Translation, Scaling, Rotation, Reflection and Shearing, concatenation.	**7**	**15 %**
II	Wireframe modeling: Curves, Curve representation, Analytic curves, Synthetic curves- Bezier, B-Spline, NURBS, Overview of CAD Applications, Introduction to surfaces representation, patches and composite surfaces, Graphics standards: GKS, IGES, PDES.	**7**	**15 %**
First Internal Examination			
III	Surface Modeling: Surface representations, surface generation methods, Analytic Surface- Plane Surface, Ruled Surface, Surface of Revolution, Synthetic Surface-Cubic, Bezier, B-spline, Blending of surfaces, surface rendering.	**7**	**15 %**
IV	Solid Modeling Techniques: Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial-Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG).	**7**	**15 %**
Second Internal Examination			
V	Computer Graphics: Mathematical principles for 2D and 3D visualization, Matrix transformations, Modeling, viewing, projection and rendering, Open GL graphics library, Meshing- Mesh topology, Data structures, Introduction to Mesh generation algorithms, Surface meshes, Element types and quality criteria.	**7**	**20 %**
VI	Advanced Modeling Concepts: Feature Based Modelling, Assembling Modeling, Behavioural Modeling, Conceptual Design & Top Down Design. Capabilities of Modeling & Analysis Packages such as Solidworks, Unigraphics, Ansys, Hyper mesh. Computer Aided Design of mechanical parts and Interference Detection by Motion analysis.	**7**	**20 %**
End Semester Examination			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6362	**Mini Project**	**0-0-4**	**2**	**2019**

Course Objectives

To make students Design and develop a system or application in the area of their specialization

Course Details

The mini project is to be allotted individually on different topics related to industrial automation and robotics. The students are allowed to do their mini project in their institute itself. The student's has to give two presentations and finally submit a project report at the end of the semester. The first presentation shall highlight the project topic, objectives and methodology for the approval of the topic. The second presentation has to cover the complete work and to be done at the semester along with the report. The Mini project is to be evaluated by a committee constituted with HOD as the chairman, PG-Coordinator, a senior faculty member and the respective guides as members.

Expected Outcome

Upon successful completion of the mini project, the student should be able to:

1. Identify and solve various problems associated with designing and implementing a system or application.
2. Test the designed system or application

08ME6362 Mini Project (L-T-P : 0-0-4) Credits: 2	
Mini Project Evaluation	Marks
Internal Continuous Assessment (Maximum Marks-100)	
Evaluation based on first presentation (*Committee*)	20
Evaluation based on second presentation (*Committee)*	30
Evaluation (*Mini project Guide*)	20
Project Report *(Committee)*	30

Course No.	Course Name	L-T-P	Credits	Year of Introduction
08ME6372	**Robotics Lab**	**0-0-2**	**1**	**2019**

Course Objectives

1. Trajectory planning of robotic manipulators.
2. To track desired trajectories of robotic manipulators and mobile robots.
3. Robot Programming using RAPID
4. Trajectory tracking, Pick & Place, collision avoidance algorithms using Robot Studio
5. Testing of algorithms for trajectory planning, trajectory tracking for robotic manipulators, and localization & path planning of mobile robots using MATLAB.

Syllabus

- Experiments on 6 DOF Robot- Moving end effector to a point, tracking trajectories in joint space, tracking a trajectory in Cartesian space, Pick & Place operation. Programming of Robots using RAPID, Familiarization of Robot Studio- creating a mechanism, trajectory tracking, reachability, collision avoidance experiments using Robot Studio.

- Experiments on differentially driven robot- Open loop and closed loop control- moving to a destination, tracking straight line & circular trajectories, Monte-Carlo localization.

- Fundamental algorithms in MATLAB- for trajectory generation in one dimensional and multidimensional space, steered mobile robots- moving to a point, following a line, following any path, moving to a pose, trajectory tracking of flying robots, Reactive Navigation, Path planning- D*, RRTs., Localization-Dead reckoning, Monte- Carlo localization, simple walking robot, modelling & control schemes of robots. PLC programming- AND, OR logic, concept of latching, different types of Timers and Counters. Programming examples with Indra logic L20 PLC, Interfacing with hydraulic/pneumatic systems.

- Exercises on Computer aided inspection and quality control: Introduction to CMM - classification - structure - components - familiarity with measurement software packages and its modules - demonstration of the capability of coordinate measuring machine using a sample component e.g. - engine block – concepts of reverse engineering and rapid prototyping technology

Expected Outcomes

Upon successful completion of this course, students will be able to:

1. Plan and track trajectories for robotic manipulators and mobile robots.
2. Program robots for a specific application.
3. Design and implement controllers for robots.
4. Able to perform computer aided inspection

08ME6372 Robotics Lab (L-T-P: 0-0-2) Credits: 1	
Internal Continuous Assessment (Maximum Marks-100)	
Assessment Procedure	Weightage (%)
Practical Records/outputs (Continuous evaluation)	50
Final Test (Experiments)	30
Final Viva-Voce	20