M.E. Industrial Automation and Robotics

Curriculum & Syllabi
(Regulation 2018)

Department of Mechanical Engineering
SRI VENKATESWARA COLLEGE OF ENGINEERING
(An Autonomous Institution, Affiliated to Anna University, Chennai)
Pennalur, Sriperumbudur TK - 602 117

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
THEORY										
1	MA18186	Advanced Engineering Mathematics	FC	4	3	1	0	4	Nil	F
2	IR18101	Industrial Data Communication*	PC	3	3	0	0	3	Nil	F
	IR18102	Computer Integrated Manufacturing System**	PC	3	3	0	0	3	Nil	F
3	IR18103	Industrial Automation	PC	3	3	0	0	3	Nil	F
4	IR18104	Microcontroller and PLC for Automation	PC	5	3	0	2	4	Nil	F
5	IR18105	Hydraulics and Pneumatics	PC	3	3	0	0	3	Nil	F
6		Professional Elective I	PE	5	3	0	2	4	Nil	M
PRACTICAL										
1	IR18111	Automation Laboratory	PC	3	0	0	3	2	Nil	F
2	IR18112	Technical Seminar	EEC	1	1	0	0	1	Nil	F
TOTAL				**30**	**22**	**1**	**7**	**27**	-	-

*** For Mechanical Stream Students and ** For circuit Stream Students**

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
THEORY										
1	IR18201	Sensors, Electrical Actuators and Drives	PC	5	3	0	2	4	Nil	F
2	IR18202	Concepts of Industry 4.0	PC	3	3	0	0	3	Nil	F
3	IR18203	Robotics for Industrial Automation	PC	4	3	1	0	4	Nil	F
4	IR18204	Flexible Manufacturing System	PC	3	3	0	0	3	Nil	F
5	IR18205	Artificial Intelligence	PC	5	3	0	2	4	Nil	F
6		Professional Elective II	PE	3	3	0	0	3	Nil	M
7	MC18081	Introduction to Research Methodology and IPR	MC	2	2	0	0	2	Nil	F
PRACTICAL										
1	IR18211	Modelling and Simulation of Manufacturing systems Laboratory	PC	3	0	0	3	2	Nil	F
2	IR18212	Robotics Laboratory	PC	3	0	0	3	2	Nil	F
TOTAL				**31**	**20**	**1**	**10**	**27**	-	-

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
THEORY										
1		Professional Elective III	PE	3	3	0	0	3	Nil	M
2		Professional Elective IV	PE	3	3	0	0	3	Nil	M
3		Professional Elective V	PE	3	3	0	0	3	Nil	M
PRACTICAL										
1	IR18311	Project Work Phase I	EEC	12	0	0	12	6	Nil	F
TOTAL				**21**	**9**	**0**	**12**	**15**	-	-

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
PRACTICAL										
1	IR18411	Project Work Phase II	EEC	24	0	0	24	12	Nil	F
TOTAL				**24**	**0**	**0**	**24**	**12**	-	-

PROFESSIONAL ELECTIVE – I

S.NO.	COURSE CODE	COURSE TITLE
1	IR18001	Additive Manufacturing
2	IR18005	Embedded Systems in Automation
3	IR18009	Industrial Internet of Things

PROFESSIONAL ELECTIVE – II

S.NO.	COURSE CODE	COURSE TITLE
1	IR18002	Data Analytics and Cloud Computing
2	IR18004	Machine Learning
3	IR18006	Modern Material Handling

PROFESSIONAL ELECTIVE – III, IV & V

S.NO.	COURSE CODE	COURSE TITLE
1	IR18003	Cyber Physical Systems
2	IR18007	Human Machine Interface
3	IR18011	Machine Vision & Image Processing
4	IR18013	Manufacturing Information System
5	IR18015	Micro-electromechanical systems & Microsystems
6	IR18017	Optimization Techniques
7	IR18019	Product Design & Development
8	IR18021	Product Life Cycle Management
9	IR18023	Virtual Instrumentation

SEMESTER I

MA18186	ADVANCED ENGINEERING MATHEMATICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the ability to use the concepts of Linear algebra for solving problems related to Networks.
- Understand the basic concepts of the probability and to apply the same for Engineering Problems
- Provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- Understand the fundamentals of random variables and to introduce some standard distributions applicable to engineering problems
- Identify appropriate test in Statistics based on the given Data and to apply them

UNIT I LINEAR ALGEBRA 12

Vector spaces – norms – Inner Products – Eigen values using QR transformations – QR factorization - generalized eigenvectors – Canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations -Toeplitz matrices and some applications.

UNIT II DESCRIPTIVE STATISTICS AND PROBABILITY 12

Introduction - Measures of central tendency-Mean, Median, Mode – Measures of Dispersion – Range, Interquartile range, Standard deviation - Probability – Axioms of probability – Conditional probability – Baye‘s theorem.

UNIT III RANDOM VARIABLES 12

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson and Normal distributions. Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Central limit theorem (for independent and identically distributed random variables).

UNIT IV TESTING OF HYPOTHESIS – SMALL SAMPLES 12

Tests based on t, F and chi-square distributions for mean, variance and proportion – Tests for independence – Goodness of fit.

UNIT V TESTING OF HYPOTHESIS – LARGE SAMPLES 12

Sampling distributions – Population and Samples – estimation of parameters – Statistical hypothesis – Confidence Interval - Large sample test for single mean, single proportion, difference of means and difference of proportions.

TOTAL: 45+15=60 PERIODS

OUTCOMES:

1. To achieve an understanding of the basic concepts of algebraic equations and method of solving them.
2. To be able to describe the applications of statistics, probability in engineering and understanding of mathematical ideas using the concept of random variables.
3. To be able to describe the applications of statistics and probability in engineering.
4. To become familiar with testing hypothesis based on mean, variance and proportion.

5. To be able to apply various mathematical tools like sampling, statistical hypothesis for real time applications.

REFERENCES:

1. Richard Bronson, Gabriel B. Costa, “Linear Algebra”, Academic Press, Second Edition, 2007.
2. Ibe. O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier, First Indian Reprint, 2007.
3. Richard A J, Irwin Miller, John Freund, Miller and Freund’s - Probability and Statistics for Engineers, Pearson Education, Asia, Eighth Edition, 2007.
4. Richard Johnson, Miller & Freund, “Probability and Statistics for Engineers”, 7th Edition, Prentice – Hall of India, Private Ltd., New Delhi, 2007.
5. Taha H.A., “Operations Research: An introduction”, Pearson Education Asia, New Delhi, Ninth Edition, 2012.

WEB RESOURCES:

1. https://phas.ubc.ca/~oser/p509/Lec_02.pdf
2. https://online.stat.psu.edu/stat505/lesson/1

IR18101	INDUSTRIAL DATA COMMUNICATION (For Mechanical Stream Students)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To educate on the basic concepts of data networks, inter-networking and serial communications
- To provide details on HART and Field buses
- To educate on MODBUS, PROFIBUS and other communication protocol
- To introduce industrial Ethernet and wireless communication

UNIT I DATA NETWORK FUNDAMENTALS 9

Networks hierarchy and switching – Open System Interconnection model of ISO - Data link control protocol - Media access protocol - Command / response - Token passing - CSMA/CD, TCP/IP

UNIT II INTERNET WORKING AND RS 232, RS 485 9

Bridges - Routers - Gateways - Standard ETHERNET and ARCNET configuration special requirement for networks used for control - RS 232, RS 485 configuration Actuator Sensor (AS) – interface, Device-net

UNIT III HART AND FIELDBUS 9

Introduction - Evolution of signal standard - HART communication protocol - HART networks - HART commands - HART applications - Fieldbus - Introduction - General Fieldbus architecture - Basic requirements of Fieldbus standard - Fieldbus topology - Interoperability - Interchangeability - Introduction to OLE for process control (OPC).

UNIT IV MODBUS AND PROFIBUS PA/DP/FMS AND FF 9

MODBUS protocol structure - function codes – troubleshooting Profibus, Introduction, Profibus protocol stack, Profibus communication model - communication objects - system operation - troubleshooting - review of foundation fieldbus - Data Highway

UNIT V INDUSTRIAL ETHERNET AND WIRELESS COMMUNICATION 9

Industrial Ethernet, Introduction, 10 Mbps Ethernet, 100 Mbps Ethernet - Radio and wireless communication, Introduction, components of radio link - radio spectrum and frequency allocation - radio MODEMs-Introduction to wireless HART and ISA100.

TOTAL: 45 PERIODS

OUTCOMES:

Students will

1. Understand the fundamentals of industrial data network.
2. Acquire knowledge on routers and other networking devices.
3. Gain knowledge on fieldbus and its architecture.
4. Learn the basics of MODBUS and PROFIBUS
5. Be able to select the appropriate communication system for industrial automation.

REFERENCES:

1. Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, Practical Industrial Data Networks Design, Installation and Troubleshooting' Newnes Publication, Elsevier First Edition, 2004.
2. William Buchanan, Computer Buses, CRC Press, 2000.
3. A. Behrouz Forouzan, Data Communications & Networking ,3RD edition, Tata Mc Graw Hill, 2006.

4. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, Prentice Hall of India Pvt. Ltd., 5th Edition. 2011.
5. Theodore S Rappaport, Wireless Communication: Principles and Practice, Prentice Hall of India 2nd Edition, 2001.
6. William Stallings, Wireless Communication & Networks, Prentice Hall of India, 2nd Edition, 2005.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106105080/

IR18102 COMPUTER INTEGRATED MANUFACTURING SYSTEM **L T P C**
(For Circuit Stream Students) **3 0 0 3**

OBJECTIVES:

- To learn the advanced manufacturing techniques.
- To develop a database for computer aided manufacturing system
- To acquire the knowledge on flexible manufacturing and material handling system.

UNIT I INTRODUCTION **9**

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

UNIT II GROUP TECHNOLOGY AND PROCESS PLANNING **9**

Group technology- role of G.T. in - part families - classification and coding – DCLASS, MICLASS and OPITZ coding systems-facility design using G.T. - benefits of G.T-cellular manufacturing. Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning – variant approach and generative approaches - CAPP and CMPP process planning systems.

UNIT III FMS AND AGVS **9**

Components of FMS - types -FMS workstation- - FMS layout –Benefits of FMS- Material handling and storage systems- Automatic storage and retrieval systems-AGVs, Guidance methods -Shop floor control factory data collection system -automatic identification methods - Bar code technology- automated data collection system- Automatically Programmed Tool.

UNIT IV CIM IMPLEMENTATION AND DATA COMMUNICATION **9**

CIM and company strategy - system modelling tools -IDEF models - activity cycle diagram CIM architecture -CIM open system architecture - manufacturing enterprise wheel- Product data management – CIM implementation-software. Communication fundamentals- local area networks topology –LAN implementations –network management and installations, PDM Tools.

UNIT V OPEN SYSTEM AND DATABASE FOR CIM **9**

Open system interconnection - Manufacturing Automations Protocol and Technical Office Protocol- Development of databases -database terminology- architecture of database systems-data modelling and data associations -relational data bases - database operators.

TOTAL: 45 PERIODS

OUTCOMES:

Students will

1. Describe various types of automation and production concepts.
2. Be able to distinguish various automated flow lines in high volume production systems.
3. Be able to analyze various automated flow lines and line balancing problem.
4. Analyze and design appropriate automated assembly systems.
5. Be able to apply Computer aided process planning, MRP and CNC part programming for different applications

REFERENCES:

1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 4th edition, 2016.
2. Radhakrishnan P, Subramanyan S and Raju V, "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
3. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.
4. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.
5. Rao P, Tewari N & Kundra T.K, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112104289/

IR18103	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the basic knowledge in automation of industrial processes.
- To learn the different automated flow lines in manufacturing industries.
- To explore the material handling and part identification techniques.
- To learn about control system, assembly system and testing in modern manufacturing industries.

UNIT I INTRODUCTION 7

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

UNIT II DETROIT-TYPE AUTOMATION 12

Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, 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, Computer Simulation of Automated Flow Lines.

UNIT III MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES 12

The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.

UNIT IV CONTROL TECHNOLOGIES IN AUTOMATION 7

Industrial Control Systems, Process Industries Verses Discrete Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, SCADA System & RTU.

UNIT V AUTOMATED ASSEMBLY AND TESTING 7

Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine. 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.

TOTAL: 45 PERIODS

OUTCOMES:

1. Understanding the basics of automation and analyze the cost effective of automated system
2. Identify the suitable flow lines and understand the computer simulation for the automation of given application
3. Describe material handling and relevant technologies for the automation
4. Differentiate various control aspects of automation.
5. Demonstrate the automation for assembly line and testing of manufacturing industry.

REFERENCES:

1. Krishna Kant, “Computer Based Industrial Control”, EEE-PHI, 2nd Edition, 2010.
2. Tiess Chiu Chang & Richard A. Wysk, “An Introduction to Automated Process Planning Systems”. Prentice-Hall, 1985.
3. Viswanandham N & Narahari Y, Performance Modeling of Automated Manufacturing Systems, PHI, 1st Edition, 2009.

WEB RESOURCES:

1. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L-01(SM)(IA&C)%20((EE)NPTEL).pdf

IR18104 MICROCONTROLLER AND PLC FOR AUTOMATION

L	T	P	C
3	0	2	4

OBJECTIVES:

- To introduce students with the architecture and operation of typical microcontrollers and PLC.
- To familiarize the students with the programming and interfacing of microcontrollers, PLC SCADA, Embedded system and DCS.
- To provide strong foundation for designing real world applications using microcontrollers, PLC, SCADA, Embedded system and DCS.

UNIT I MICROCONTROLLER **10**

Introduction, Comparing Microprocessors and Microcontrollers, Z-80, 8051, PIC Micro Controllers, PIC Development Tools. The Micro Controller Survey, 4Bit, 8Bit, 16 Bit and 32 Bit Micro Controllers. Develop Systems for Micro Controllers. Micro Controllers Architecture: 8051 Architecture, PIC Architecture, 8051 Micro Controller Hardware, Input/Output Pins, Ports and Circuits, External Memory, Counter and Timers, Serial Data Input/Output, (SLE: Interrupts).

UNIT II MICRO CONTROLLER PROGRAMMING & APPLICATIONS **8**

Simple programming exercises- key board and display interface –Control of servo motor, stepper motor control- Application to automation systems.

UNIT III PLC **9**

Programmable Logic Controllers: Introduction – Parts of PLC – Principles of operation – PLC sizes – PLC hardware components – I/O section Analog I/O Section Analog I/O modules – digital I/O modules CPU processor memory module – Programming devices – PLC programming Simple instructions - Latching relays PLC ladder diagram, Applications of PLC - Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, Motor control.

UNIT IV SCADA **9**

Introduction to SCADA. TAG's – Types – Analog – Digital – Strings – Memory – I/O tags. PC-SCADA- Memory analog/digital/string tag. PLC-SCADA – I/O analog/digital/string tag. Features of SCADA – Dynamic process graphic – Real-time and historical trending – Alarms – Recipe management – Security – Device connectivity – Script for logic development – Database connectivity. Case studies.

UNIT V DISTRIBUTED CONTROL SYSTEM **9**

Introduction to DCS – Centralized versus Distributed control system. Components of DCS – Field Control Station – Operator Station – Communication Bus. Human Interface Station, Engineering Station – Communication Gateway – Bus converter. Programming and Simulation.

LABORATORY COMPONENT

OBJECTIVES:

- To introduce and train the students to use microcontroller for industrial applications
- To acquire knowledge on PLC for actuation and control of speed of motors.

LIST OF EXPERIMENTS

1. Assembly language programming and simulation of 8051 in Keil IDE.
2. Alphanumeric and Graphic LCD interfacing using X8051 & PIC Microcontroller.
3. Sensor interfacing with ADC to X8051 & PIC.
4. DAC & RTC interfacing to X8051 & PIC.
5. Timer, Counter and Interrupt program application for X8051 and PIC.

6. Stepper motor (unipolar & bipolar motor) and PWM servo motor control to interfacing with X8051.
7. UART serial programming in X8051 and PIC.
8. Programming on single board computers for sensor and actuator interface.
9. Programming & Simulation of cascade circuit $A^+ B^+ B^- A^-$ using PLC.
10. Programming & Simulation of cascade circuit $A^+ B^+ B^- C^+ C^- A^-$ using PLC.

TOTAL: 45+30 = 75 PERIODS

OUTCOMES:

Students will

1. Be able to apply microcontroller for controlling different actuators.
2. Gain the knowledge on microcontroller and its programming.
3. Acquire knowledge on PLC and do simulation using PLC for different industrial applications.
4. Gain knowledge on SCADA.
5. Be able to apply the distributed control system for automation.

REFERENCES:

1. Mandal S.K , "Microprocessors and Microcontrollers", WBUT Series by TMH.
2. Ram B, "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai Publications.
3. Kenneth J. Ayala "The 8085-micro controller-Architecture, Programming & Applications" Penram Publishing, 1997.
4. Frank D. Petruzella, "Programmable Logic Controller", 4th Edition, The McGraw-Hill, 2011.
5. Steve Heath, "Embedded Systems Design", Newnes publication, 2nd Edition, 2003.
6. Tracy Adams, P.E., "SCADA System Fundamental", CED engineering.com.
7. Frank Lamb, "Industrial Automation Hands-on" The McGraw-Hill, 2013.
8. Manual prepared by Departments of Mechanical & Electronics and communication of SVCE.

WEB RESOURCES:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/108105088/lec25.pdf
2. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod3.pdf

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. 8051 Microcontroller Trainer Kit with Software-3 No's
2. PLC Trainer Kit with Software -3 No's
3. ARM 7 Trainer Kit with Software -3 No's
4. Computers-12 No's
5. DAC/ADC interface-3
6. Servomotor – 3 no's
7. Stepper motor -3 no's

IR18105	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course will give an appreciation of the fundamental principles, design and operation of hydraulic systems.
- Students will gain knowledge on pneumatic systems and their application in recent automation.

UNIT I FLUID POWER FUNDEMENTALS AND PUMPS 12

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluid power system - Hydraulics and Pneumatics. Hydraulic fluids and their Properties. Pascal's Law, Darcy's equation. Valves and fittings. Losses in pipes and fittings - K factor. Sources of Hydraulic power: Pumping Theory – Pump Classification - Construction, Working, Design, Advantages, Disadvantages & Performance of Linear, Rotary, Fixed and Variable displacement pumps - Selection criterion.

UNIT II HYDRAULIC SYSTEM COMPONENTS 10

Hydraulic Actuators - Cylinders & Motors – Types and construction, Control Components - Directional control, Flow control and Pressure control valves - Types, Construction, Operation and Applications. Fluid Power ANSI Symbol.

Accessories: Pressure Switches, Electrical switches, Limit switches, Relays-Applications- Types of Accumulators and its Applications. Pressure Intensifier.

UNIT III DESIGN OF HYDRAULIC CIRCUITS 8

Design of Hydraulic circuits - Reciprocation, Speed control- Meter-in & Meter-out circuits, Sequence, Synchronization, Regenerative, Pump Unloading - Double pump, Air-over oil system, Electro hydraulic circuits.

UNIT IV PNEUMATIC SYSTEM COPONENTS 8

Properties of air– Perfect Gas Laws - Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Introduction to Fluidics, Pneumatic logic circuits.

UNIT V INDUSTRIAL HYDRAULIC AND PNEMATIC CIRCUITS 7

Design of circuits using the components of hydraulic system for Shaping, Punching, Pressing operations. Sequential circuit design for simple application using cascade method. Design of electro pneumatic circuits.
Microprocessor and PLC- Applications in Hydraulic and Pneumatics, Low cost Automation.

TOTAL: 45 PERIODS

OUTCOMES:

Students will

1. Gain theoretical knowledge of principles of fluid power systems and pumps.
2. Be able to select the hydraulic components for industrial applications.
3. Design the hydraulic circuits for different .
4. Be able to select the pneumatic components for industrial applications.
5. Apply the hydraulic and pneumatic circuits for industrial applications.

REFERENCES:

1. Anthony Esposito, "Fluid Power with Applications", PHI / Pearson Education, 2005
2. James L. Jhonson. "Introduction to Fluid Power", Delmar Thomson Learning, 2002.
3. Dudelyt, A Pease and John J Pippenger, Basic Fluid Power, Prentice Hall, 1987.

4. Majumdar S.R, “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw Hill, 2001.
5. Majumdar S.R, “Pneumatic Systems – Principles and Maintenance”, Tata McGraw Hill, 2007.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112105046/

IR18111	AUTOMATION LABORATORY	L	T	P	C
		0	0	3	2

OBJECTIVES:

- To train the students in designing and practical implementation of hydraulic and pneumatic circuits using ladder diagram.
- To acquire knowledge on simulation principles using automation software.
- To acquire knowledge in the concept of programming the multi axis robot.

LIST OF EXPERIMENTS

1. Design of pneumatic circuits and show the operation using basic pneumatic trainer kit
2. Design of pneumatic circuits and show the operation using electro pneumatic trainer kit
3. Design of pneumatic circuits and show the operation using PLC electro pneumatic trainer kit
4. Design of pneumatic circuits and show the operation using basic hydraulic trainer kit
5. Design of pneumatic circuits and show the operation using PLC electro hydraulic trainer kit
6. Design and Simulation of hydraulic circuits using Automation studio software
7. Design and Simulation of pneumatic circuits using Automation studio software
8. PLC control circuit design and simulation using Automation studio software
9. Motor control using PLC (Servo, Stepper, DC & AC Motors)
10. Modeling of DC motor using MATLAB
11. Applications using PLCs (Traffic light, Bottle filling, Lift etc.)
12. Closed loop control of a variable speed drive using PLC, SCADA

TOTAL: 45 PERIODS

OUTCOMES:

Students will be

1. Capable to design and simulate the hydraulic circuits for different applications.
2. Able to design and simulate the pneumatics circuits for industrial applications.
3. Able to programme and operate the industrial robot.

REFERENCES:

1. Laboratory Manual Prepared by Department of Mechanical Engineering.
2. Mechatronics training practice module, FESTO manual Germany, 2011.
3. Ashitava Ghosal, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press, 2008.
4. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, “Industrial Robotics Technology, Programming and Applications”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.

WEB RESOURCES:

1. http://www.nitc.ac.in/electrical/ipg/ipa_labs/101/ipa%20101%20man.pdf

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Hydraulic Trainer Kit with Pump and Valves – 2 No's
2. Pneumatic Trainer Kit with Compressor and Valves – 1 No
3. Electro Pneumatic Trainer Kit – 1 No
4. Electro Pneumatic Trainer Kit with PLC – 1 No
5. Electro Hydraulic Trainer Kit with PLC – 1 No
6. Hydraulics and Pneumatics Simulation Software – each 5 Licenses
7. System Controlled DC Motor with Feedback Setup -1 No
8. System Controlled AC Motor with Feedback Setup – 1 No
9. System Controlled Stepper Motor Setup – 2 No's
10. MATLAB/SCILAB/ any other Software for Controller Tuning – 5 Licenses
11. PLC application modules - 1 set
12. Automation Studio Software – 5 Licenses
13. Hydrosim and Pneumosim software – each 5 Licenses
14. Personal Computers -10 No's

IR18112	TECHNICAL SEMINAR	L	T	P	C
		1	0	0	1

METHOD OF EVALUATION:

During the seminar session each student is expected to prepare and present a topic on Automation & Robotics, for duration of about 15 to 20 minutes. In a session of a period per week, students are expected to present the seminar. Each student is expected to present at least once during the semester and the student is evaluated based on their performance. At the end of the semester, He/She will submit a report on His/Her topic of seminar and are awarded based on the report presentation. Evaluation is 100% Internal.

TOTAL: 15 PERIODS

OUTCOMES

Students will

1. Be able to review, prepare and present on recent technological developments
2. Gain the ability to utilize teaching aids.
3. Be able to prepare technical report & gain confidence to face the placement interviews.

SEMESTER II

IR18201	SENSORS, ELECTRICAL ACTUATORS AND DRIVES	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To learn the various types of IoT based sensors & transducers used for industrial automation
- To acquire knowledge on electric actuators and their drives used for automation of industrial processes.

UNIT I PROXIMITY, DISPLACEMENT AND RANGING SENSORS 10

Sensors & Transducers - Classification of sensors - Static and Dynamic characteristics of sensors. Proximity Sensors – Inductive sensor – Capacitive sensor – Optical sensor – Eddy current sensor, Ultrasonic sensor & RFID sensor & Laser sensor.

Displacement Sensors - Linear and Rotary displacement sensors - Potentiometer - Optical encoder, Magneto strictive sensor. Image sensors – CCD (Charge-coupled device), CMOS (Complementary metal-oxide semiconductor)

UNIT II FORCE, PRESSURE AND TEMPERATURE SENSORS 9

Strain Gauge – Piezoelectric Sensor - Diaphragm Pressure Sensor- Capsule Pressure sensors- Bellows Pressure Sensor- Tactile sensor.

Temperature – Thermocouples- Thermistors -Thermo-diodes – Thermo-transistors- IC (Semiconductor) - Resistance Temperature Detector- Infrared sensors. Vibrometer and accelerometer- Seismic accelerometer.

UNIT III SIGNAL CONDITIONING 8

Need for Signal Conditioning — Filter and Isolation Circuits – Operational Amplifier Specifications, Characteristics and Circuits – Fundamentals of Data Acquisition System.

UNIT IV ELECTRICAL ACTUATORS 9

D.C Motor-Working principle – Classification – Characteristics - Merits and Demerits - Applications. AC Motor - Working principle - Types, Speed & Torque characteristics - Merits and Demerits – Applications. Stepper motor – Working principle – Classification - Construction. Piezo electric actuators – Linear actuators Hybrid actuators – Applications.

UNIT V ELECTRICAL DRIVE CIRCUITS 9

DC Motors - Speed, direction and position control using H-bridge under PWM mode. Control of AC motor – Need for V/ F drives – Energy saving AC drives. – Stepper Motor – Drive circuits for speed and position control, BLDC motor – Controller – Switched reluctance motor.

LABORATORY COMPONENT

OBJECTIVES:

To learn and gather the practical experience on sensors and its applications for automation.

LIST OF EXPERIMENTS

1 Study on various kinds of sensors and its characteristics.

2 Study on signal conditioning units.

3 Experimentation on voltage, current, power, and frequency measurement.

4 Applications of strain gage & load cell for force measurement.

5 Study of torque transducer & applications.

6 Experimentation with tactile sensor for force and touch detection.

7 Study of pressure sensor.

8 Use of LVDT & acoustics ranging.

9 Study of hall-effect sensor and ultrasonic distance measurement applications.

10 Use of different temperature sensors.

11 Optical transducers Characterization.

12 Data Acquisition & Instrument Control

TOTAL:45+30= 75 PERIODS

OUTCOMES:

1. Students will be able to identify proximity and displacement sensors and apply the same for automation.
2. To understand and practice on different sensors and apply them for measuring parameters like pressure, force and temperature.
3. Acquire the knowledge of signal conditioning and data acquisition.
4. Graduates will able to select the suitable electrical actuators for the industrial automation.
5. Acquire knowledge on selection of electrical drives for the specific actuators.

REFERENCES:

1. Patranabis D., “Sensor and Actuators”, Prentice Hall of India (Pvt) Ltd., 2010.
2. Renganathan S., “Transducer Engineering”, Allied Publishers (P) Ltd., 2003
3. GopalK.Dubey, “Fundamentals of Electrical Drives”,Narosa Publications, 2015.

WEB RESOURCES:

1. https://nptel.ac.in/courses/108108147/

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Temperature Sensors (RTD, Thermocouple, Thermistor)- 1 in Each
2. Optical sensors – 1 No’s
3. Strain Gauge Trainer – 1 No’s
4. Load cell – 1 No’s
5. Torque Transducer Trainer – 1 No’s
6. LVDT and Hall Effect Trainer – 1 No’s on Each
7. Pressure sensor, ultrasonic senor Trainer – 1 No’s on Each
8. Proximity sensor (Eddy current, optical, inductive, capacitive principle) – 1 No’s on Each
9. Tactile sensor (force and touch) Trainer– 1 No’s
10. DAQ card – 6 No’s
11. Personal Computer – 5 No’s.

IR18202	CONCEPTS OF INDUSTRY 4.0	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To create an awareness on different components of Industry 4.0
- To make the students to understand the complete architecture of I4.0
- To impart an inter-relationship between the components of I4.0 and its adoption in I4.0.

UNIT I INTRODUCTION AND CYBER PHYSICAL SYSTEM 7

Industry 4.0- Components of I4.0-Cyber Physical System –Cyber world and Physical world-Concepts of embedded systems, Wireless sensor networks, Mobile networks, Satellite networks and RFID & IoT.

UNIT II AI, MACHINE LEARNING AND BIG DATA AND ANALYTICS 10

Definition of AI – Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems. Machine learning and its types. Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs. Reporting.

UNIT III ADDITIVE MANUFACTURING, SIMULATION, AR & VR 10

Overview – History – Need-Classification -Additive Manufacturing Technology in product development-Materials for Additive Manufacturing Technology – Tooling –Simulation of physical arrangement of transporters, conveyors etc. , Production scheduling, and factory layout design. System Structure of Augmented Reality. Key Technology in AR, Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality.

UNIT IV AUTONOMOUS ROBOTS AND IIoT 9

Autonomous robots- Types- .Mobile robots and its applications- The elements of IIoT - Sensors, Communication, LPWAN, IIoT Architecture, Design considerations and IoT Security-Industrial case studies.

UNIT V CLOUD COMPUTING, SYSTEM INTEGRATION AND CYBER SECURITY 9

Introduction to cloud computing: cloud models, cloud service examples, cloud based services & applications,-Horizontal and vertical system integration – Need of cyber security-Types of attack.

TOTAL : 45 PERIODS

OUTCOMES:

Students will

1. Understand different components of I4.0 and its benefits
2. Understand the importance of AI and Big data analytics in modern industry
3. Visualize the complete factory layout and processes by simulation, AR/VR
4. Be Exposed to real time autonomous robot and its applications
5. Gain knowledge about Cloud technology and its benefits

REFERENCES:

1. Ustundag, Alp, Cevikcan, Emre, Industry 4.0: Managing The Digital Transformation, Springer, 2018.
2. Giacomo Veneri , Antonio Capasso ,Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0, Kindle Edition, 2017.

3. Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Kindle Edition, 2018.
4. Amita Kapoor, Hands-On Artificial Intelligence for IoT: Expert machine learning and deep learning techniques for developing smarter IoT systems, Kindle Edition, 2017.
5. Alena Traukina, Jayant Thomas , Prashant Tyagi , Kishore Reddipalli , Industrial Internet Application Development: Simplify IIoT development using the elasticity of Public Cloud and Native Cloud Services 1st Edition, Kindle Edition, 2019.
6. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things 1st ed. Edition, Kindle Edition, 2018.

WEB RESOURCES:

1. https://new.siemens.com/global/en/company/topic-areas/digital-enterprise.html
2. https://blog.flexis.com/the-key-components-of-industry-4.0
3. https://www.bcg.com/en-in/capabilities/operations/embracing-industry-4.0-rediscovering-growth.aspx

IR18203 ROBOTICS FOR INDUSTRIAL AUTOMATION

L	T	P	C
3	1	0	4

OBJECTIVES:

- To enlighten the students about the fundamentals of robotic systems.
- To familiarize the students with the fundamentals of sensors and various drive systems.
- To execute knowledge about basics of kinematic of robot manipulators.

UNIT I BASICS OF ROBOTICS **12**

Basic Concepts – Definition – Need for robots – Three laws – Degrees of Freedom. Robot – Components of a robot, Classification of robots Articulated – Cartesian – Cylindrical – Polar – SCARA – Delta – Robot anatomy – Co-ordinate systems, Work envelope – Specifications – Pitch, yaw, roll, joint notations, speed of motion and pay load – Robot parts and their functions — Different industrial applications.

UNIT II ROBOT END EFFECTOR AND VISION SYSTEM **12**

End effectors – Grippers: Mechanical grippers, Hydraulic & Pneumatic grippers, Magnetic grippers, Vacuum grippers, RCC grippers – Two and three fingered grippers – Internal and external grippers – Selection considerations, Gripper force analysis.

Camera, frame grabber, sensing and digitizing image data – Signal conversion – Image Storage – Image processing and analysis – Data reduction – Segmentation – Feature extraction – Object recognition – Applications – Inspection, identification, visual serving and navigation.

UNIT III KINEMATICS AND DYNAMICS OF ROBOT **12**

Manipulator kinematics – Forward kinematics – Inverse kinematics – Differences: Forward kinematics and Reverse kinematics of manipulators with two and three degrees of freedom (In 2 dimensional), four degrees of freedom (In 3 dimensional) – Deviations and problems. Robot dynamics.

UNIT IV ROBOT CONTROL SYSTEMS AND PROGRAMMING **12**

Teach pendant programming – Lead through programming – Robot programming languages – Robot programming as a path in space, Motion interpolation – Robot Languages: Textual robot Languages, Generation.

Types of transmission, Basics of control Systems – Open loop and Closed loop system – Types of Controllers, Process Control Systems, Discrete Control System, Continuous Versus Discrete Control. Linear and Non-linear controls.

UNIT V APPLICATIONS OF ROBOT **12**

Robot Application – Implementation of robots in industries – Various steps, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application.
Types of locomotion, Hopping robots, Legged robots, Wheeled robots, Wall climbing robots, COBOTS, Sensors for mobile robots like global positioning system (GPS), Path planning algorithms, Stochastic dynamic programming (SDP).

TOTAL:45+15= 60 PERIODS

OUTCOMES:

Students will

1. Acquire basic knowledge on industrial robots.
2. Be able to select the suitable end effectors and vision systems for various applications.
3. Design and analyze the manipulators of robots.
4. Be able to develop the programme and select the control system for robotic applications.

5. Select the appropriate robots for different industrial applications.

REFERENCES:

1. Deb S.R, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education, 2nd Edition 2017.
2. Mikell P Groover& Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, “Technology Programming and Applications”, McGraw Hill, 2012.
3. Richard D. Klafter, Thomas A, Chri Elewski, Michael Negin, “Robotics Engineering an Integrated Approach”, Phi Learning., 2009.
4. Saeed B Niku, “Introduction to Robotics Analysis, Control and Application” Wiley student 2nd Edition,

WEB RESOURCES:

1. https://nptel.ac.in/courses/112/105/112105249/

IR18204 FLEXIBLE MANUFACTURING SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

- To acquire knowledge on process planning and scheduling manufacturing system.
- To learn about automated material handling system in industries.
- To apply the knowledge of group technology and FMS for the automation of industrial processes.

UNIT I PLANNING, SCHEDULING AND CONTROL OF FMS 9

Introduction To FMS– Development of Manufacturing Systems – Benefits – Major Elements – Types of Flexibility – FMS Application and Flexibility –Single Product, Single Batch, N – Batch Scheduling Problem – Knowledge Based Scheduling System.

UNIT II COMPUTER CONTROL AND SOFTWARE FOR FMS 9

Introduction – Composition of FMS– Hierarchy of Computer Control –Computer Control of Work Centre and Assembly Lines – FMS Supervisory Computer Control – Types of Software Specification and Selection – Trends.

UNIT III FMS SIMULATION AND DATA BASE 9

Application of Simulation – Model of FMS– Simulation Software – Limitation – Manufacturing Data Systems – Data Flow – FMS Database Systems – Planning for FMS Database.

UNIT IV GROUP TECHNOLOGY AND JUSTIFICATION OF FMS 9

Introduction – Matrix Formulation – Mathematical Programming Formulation –Graph Formulation – Knowledge Based System for Group Technology – Economic Justification Of FMS- Application of Possibility Distributions in FMS Systems Justification.

UNIT V APPLICATIONS OF FMS AND FACTORY OF THE FUTURE 9

FMS Application in Machining and Fabrication, Prismatic Component Production, Material handling – AGV- RGV– Aerospace Application – FMS Development Towards Factories of The Future – Artificial Intelligence and Expert Systems in FMS – Design Philosophy and Characteristics for Future.

TOTAL: 45 PERIODS

OUTCOMES:

Students will

1. Apply the concepts of PPC and GT to the development of FMS.
2. Be able to discuss the planning and scheduling methods used in manufacturing systems.
3. Identify various workstations, system support equipment.
4. Be able to identify hardware and software components of FMS.
5. Summarize the concepts of modern manufacturing such as JIT, supply chain management and lean manufacturing etc.

REFERENCES:

1. Jha N.K “Handbook of Flexible Manufacturing Systems”, Academic Press Inc., 2006.
2. Radhakrishnan P and Subramanyan S, “CAD/CAM/CIM”, Wiley Eastern Ltd., New Age International Ltd., 2001.
3. Raouf A. and Ben-Daya M, Editors, “Flexible Manufacturing Systems: Recent Development”, Elsevier Science, 2000.

4. Groover M.P., “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India Pvt., New Delhi, 1996.
5. Kalpakjian, “Manufacturing Engineering and Technology”, Addison-Wesley Publishing Co., 1995.
6. Taiichi Ohno, “Toyota Production System: Beyond Large-Scale Production”, Productivity Press (India) Pvt. Ltd. 1992.

WEB RESOURCES:

1. http://www.ignou.ac.in/upload/UNIT6-55.pdf

IR18205	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To understand the basic concepts of artificial intelligence
- To Utilize various search and matching techniques used in artificial intelligence
- To develop the problem solving skill using AI

UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

History, Definition of AI and Emulation of human cognitive process- Agents: types- An abstract view of modelling and Elementary knowledge- Computational and Predicate logic- Analysis of compound statements using simple logic connectives- Nature of Environments.

UNIT II PROBLEM SOLVING AGENTS 9

Problem Definition, Formulating problems and Searching for solutions- Examples using production rules-Search/Strategies: Uninformed or Blinded search and Breadth first search- Uniform cost search: Depth first search, Depth limited search- Iterative deepening, Depth first search and Bi – directional search- Comparing uniformed search strategies and Informed search strategies- Heuristic information and Hill climbing methods- Best First Search; Greedy Best First Search, Branch-and Bound Search.

UNIT III KNOWLEDGE ORGANISATION AND COMMUNICATION 9

Knowledge organization, manipulation and acquisition- Indexing and Retrieval techniques and Integration of knowledge in memory organization systems- Matching Techniques: Need for matching and simple Matching problems- Partial matching, Fuzzy matching and RETE matching algorithm- Perception- Natural language: Overview of linguistics and Basic semantic analysis - Representation structures and Natural language generation- Uncertainty- Bayesian Networks and Bayesian Inference.

UNIT IV INTELLIGENCE SYSTEM 9

Handling uncertainty and learning: Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions.

UNIT V INTRODUCTION TO MACHINE LEARNING 9

Basic concepts, linear models, perceptron, K nearest neighbours, advanced models, neural networks, SVMs, decision trees and unsupervised learning, Markov decision processes and reinforcement learning, Logical Agent, propositional logic and first order logic.

LABORATORY COMPONENT

OBJECTIVES:

To learn and gather the practical experience on sensors and its applications for automation.

LIST OF EXPERIMENTS

1 Implement Tic-Tac-Toe game

2 Implement Breadth, Depth first Search for various problems

3 Implement Best first Search for various problems

4 Implement Min-max search trees

5 Implement Forward chaining reasoning algorithm

6 Implement Backward chaining reasoning algorithm

7 Implement Genetic Algorithm

8 Implement K-nearest neighbors

9 Implement Learning using neural networks

10 Implement Decision trees

11 Implement Propositional calculus

12 Implement First order logic related problem

TOTAL:45+30= 75 PERIODS

OUTCOMES:

Students will

1. Understand of the history of artificial intelligence (AI) and its foundations.
2. Will apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
3. Be able to demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
4. Develop applications in an 'AI language', expert system shell, or data mining tool.
5. Be able to demonstrate proficiency in applying scientific method to models of machine learning.

REFERENCES:

1. Deepak Khemani, "A First Course in Artificial Intelligence", Tata McGraw Hill Publications, 2013.
2. S. Russel and Norvig P,"AI: A modern approach", Pearson Education, 3rd Edition, 2009.
3. Eugene Charniak and Drew McDermot, “Introduction to Artificial Intelligence”, Addison Wesley Longman Inc., 2016.
4. Elaine Rich and Kelvin Knight, “Artificial Intelligence”, Tata McGraw Hill Publications, New Delhi, 2011.
5. Schalkoff R.J, “Artificial Intelligence: An Engineering Approach”, Tata McGraw-Hill Publications, 2012.

WEB RESOURCES:

1.https://nptel.ac.in/courses/106/105/106105077/

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Personal computers – 45 No’s
2. Software like
   - Prolog,
   - Java,
   - Python,
   - LISP

MC18081 INTRODUCTION TO RESEARCH METHODOLOGY AND IPR

L	T	P	C
2	0	0	2

OBJECTIVES:

- To impart knowledge on formulation of research problem, research methodology, ethics
- involved in doing research and importance of IPR protection.

UNIT I RESEARCH METHODOLOGY 6

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics.

UNIT II RESULTS AND ANALYSIS 6

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.

UNIT III TECHNICAL WRITING 6

Effective technical writing, how to write a manuscript/responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.

UNIT V PATENT RIGTS AND NEW DEVELOPMENTS IN IPR 6

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.

TOTAL:30 PERIODS

OUTCOMES:

At the end of this course, students will be able to

1. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
2. Understand research problem formulation & Analyze research related information and Follow research ethics.
3. Correlate the results of any research article with other published results. Write a review article in the field of engineering.
4. Appreciate the importance of IPR and protect their intellectual property. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

REFERENCES:

1. Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005.
2. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press, 2004.
3. Ramappa T, “Intellectual Property Rights Under WTO”, S. Chand, 2008.
4. Kothari C. R, “Research Methodology - Methods and Techniques”, New Age International publishers, New Delhi, 2004.
5. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”, Juta & Company, 1996.
6. Niebel, “Product Design”, McGraw Hill, 1974.
7. Asimov, “Introduction to Design”, Prentice Hall, 1962.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106/105/106105077/

IR18211	MODELLING AND SIMULATION OF MANUFACTURING SYSTEMS LABORATORY	L	T	P	C
		0	0	3	2

OBJECTIVES:

- To learn the basic concepts of modeling and simulation and apply them for various applications
- To learn the methodology of modeling and simulation of various industrial plants.

LIST OF EXPERIMENTS

1. Modeling and Simulation of work stations
2. Modeling and Simulation of storage systems
3. Modeling and Simulation of Material Handling – Conveyors.
4. Modeling and Simulation of Material Handling – Robots.
5. Modeling and Simulation of Manufacturing Control Systems
6. Modeling and Simulation of Assembly line
7. Modeling and Simulation of Testing & Inspection Center
8. Modeling and Simulation of Packaging line
9. Modeling and Simulation of Manufacturing Industry plant
10. Modeling and Simulation of Food Processing Industry plant

TOTAL: 45 PERIODS

OUTCOMES

Students will be able to

1. Simulate the individual workstations of manufacturing industries.
2. Model and simulate the assembly lines of manufacturing industry.
3. Model and simulate the workstations of food processing industry.

REFERENCES :

1. Laboratory Manual Prepared by Department of Mechanical Engineering

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Personal Computers – 30 No’s
2. Automation Studio Software – 5 Licenses
3. Hydrosim and Pneumosim software – each 5 Licenses
4. Modeling software like
    - CREO V3.0
    - Ansys v12.0
    - AutoCAD V2016
    - Msc Adams Software
    - STAR-CD Software
    - Ideas (Master Series)
    - CATIA V5 R13
    - Autodesk Mechanical Desktop 6.0

- FLUENT / GAMBIT
- TURBOCAD 3D MODELER
- TurboCAD
- Totalcad
- SWIFT CAD
- FLOOR PLAN 3D DESIGN SUITE

IR18212	ROBOTICS LABORATORY	L	T	P	C
		0	0	3	2

OBJECTIVES:

- To train the students in designing and practical implementation of hydraulic and pneumatic circuits using ladder diagram.
- To acquire knowledge on simulation principles using automation software.
- To acquire knowledge in the concept of programming the multi axis robot.

LIST OF EXPERIMENTS

1. Forward kinematics and validate using a software (Robo Analyzer or any other open source software)
2. Inverse Kinematics of the real robot and validation using a software (Robo Analyzer or any other open source software)
3. Positioning and Orientation of robot arm
4. Kinematic simulation using MATLAB robotic tool box
5. Dynamic simulation using MATLAB robotic tool box
6. Design and control of mobile robot
7. Design and control of wall climbing robot
8. Simulation of planar and spatial mechanisms using ADAMS view/Roboanalyzer
9. Programming and control of multi--axis robot for pick and place the object
10. Path and trajectory planning of multi-axis robotic manipulator
11. MIG welding using robot
12. Wire Arc Additive Manufacturing using robot

TOTAL : 45 PERIODS

OUTCOMES:

Students will be

1. Capable to design and simulate the forward and inverse kinematics of the robots
2. Able to perform the kinematic & dynamic simulation using MATLAB software
3. Able to programme and operate the industrial robot.
4. Able to design the mobile and wall climbing robots
5. Able to perform various welding operations using robot

REFERENCES:

1. Laboratory Manual Prepared by Department of Mechanical Engineering.

WEB RESOURCES:

1. https://joyofgiving.alumni.iitm.ac.in/projects/department/robotics-teaching-lab

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. MATLAB with robotic tool kit – 5 licenses
2. Accessories for designing mobile robots
3. Accessories for designing wall climbing robots

4. Articulated robot for pick and place application
5. Robotic Manipulator for welding applications
6. ADAMS – software – 5 Licenses
7. Roboanalyzer software.
8. Personal Computers – 5 No’s

PROFESSIONAL ELECTIVE – I

IR18001	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To educate students with fundamental and advanced knowledge in the field of Additive Manufacturing.
- To familiarize the students on different technologies of Additive Manufacturing.
- To acquire knowledge on Rapid prototyping & Rapid tooling.
- To explore the file format of Additive Manufacturing system.
- To explore the applications of Additive manufacturing technology in Aerospace, Architecture, Art, Medical and Manufacturing industries.

UNIT I INTRODUCTION 8

Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

UNIT II LIQUID AND SOLID BASED AM SYSTEMS 8

Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Process, working principle, photopolymers, photo polymerization, Layering technology, Applications, Advantages and Disadvantages, Case studies.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT III POWDER BASED AM SYSTEMS 11

Selective laser sintering (SLS): Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Process, working principle, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping

(LENS): Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Process, working principle, Applications, Advantages and Disadvantages, Case studies

UNIT IV AM DATA FORMATS AND SOFTWAR 9

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, 3-matic, Simplant, MeshLab.

UNIT V RAPID TOOLING AND APPLICATIONS OF AM 9

Rapid Tooling: Introduction to Rapid Tooling (RT), Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, Planning and simulation of complex surgery, Customized Implants & Design and Production of Medical Devices, Forensic Science and Anthropology, Web Based Rapid Prototyping Systems.

LABORATORY COMPONENT

OBJECTIVES:

To expose and train the students on different 3D printing technologies and enable them to produce the physical components for different industrial applications.

LIST OF EXPERIMENTS

1. Introduction to Additive Manufacturing.
2. Generating STL files from the CAD Models & Working on STL files.
3. Modeling Creative Designs in CAD Software.
4. Processing the CAD data in CURA & CHITUBOX software.
5. Simulation in Catalyst Software for optimizing build-time and material consumption.
6. Fabricating physical part on FDM 3D printer for the automotive applications.
7. Fabricating physical part on DLP 3D printer for dental applications.
8. Removing the supports & post processing (cleaning the surfaces).
9. Evaluating the quality of the fabricated part in terms of surface finish and dimensional accuracy.
10. Evaluating the fabricated part for its suitability to a given application

TOTAL:45+30= 75 PERIODS

OUTCOMES:

Students will

1. Be able to explain the principles of Additive Manufacturing.
2. Apply the knowledge gained on AM for various manufacturing industries.
3. Be able to evaluate the Rapid Tooling techniques involved in AM
4. Be able to select the suitable AM technique for different materials.
5. Be able to fabricate the physical part using 3D printers.

REFERENCES:

1. Chua C.K, Leong K.F and LIM C.S, “Rapid prototyping: Principles and Applications”, World Scientific publications, Third Edition, 2010.
2. Pham D.T and Dimov S.S, “Rapid Manufacturing” Springer, 2001
3. Terry Wohlers, Wholers Report 2000, Wohlers Associates, 2000
4. Frank W. Liou, “Rapid Prototyping & Engineering Applications”, CRC Press, Taylor & Francis Group, 2011.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112104265/
2. https://learn-xpro.mit. edu/additivemanufacturing?utm_medium=sem&utm_source=google&utm_campaign=amx &utm_ter m=3d%20printing%20course&utm_content=aw-c

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. FDM technology Dual Extruder 3D printer – 1 No.
2. DLP technology 3D printer – 1 No.
3. FDM technology Single extruder – Do It Yourself 3D printers – 2 No's
4. Personal Computers with CURA & CHITUBOX 3D printing software – 10 No's

IR18005 EMBEDDED SYSTEMS FOR AUTOMATION

L	T	P	C
3	0	2	4

OBJECTIVES:

- To impart knowledge on the following Topics
- Fundamentals of ARM Controller and its architecture.
- Understanding the ARM instruction set for programming.
- Bus Communication in processors, Input/output interfacing.
- Basics of Real Time Operating System and various scheduling algorithms.
- Various Real time applications of Embedded systems

UNIT I INTRODUCTION **9**

ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families.

UNIT II ARM PROGRAMMING MODEL **9**

Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions.
Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions

UNIT III EMBEDDED NETWORKING **9**

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C), ISA/PCI Bus protocols, 802.11, Bluetooth, ZigBee.

UNIT IV REAL TIME OPERATING SYSTEMS **9**

Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Task, Tasks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Semaphores, Message Queue, States, Content, Storage.

Scheduling Methods: weighted round robin Approach, Priority driven Approach, Earliest deadline first (EDF) algorithm.

UNIT V CASE STUDY **9**

Automotive Application- Embedded Airbag System, Automatic Braking System in Car, Adaptive Cruise Control, Embedded Based Automatic Parking System, Smart card System Application, Navigation system.

LABORATORY COMPONENT

OBJECTIVES:

To learn and gather the practical experience on embedded systems and its applications for automation.

LIST OF EXPERIMENTS

The following Programs are to be implemented on ARM Processor

1. Study of Integrated Development Environment (IDE)
2. Simple Assembly Program for Addition, Subtraction, Multiplication, Division
3. Write an Assembly programs to configure and control General Purpose Input/Output (GPIO) port pins.
4. Program to Interface 8 Bit LED and Switch Interface
5. Program to Displaying a message in a 2-line x 16 Characters LCD display
6. Interfacing LED and PWM
7. Interfacing ADC and DAC.

8 Transmit a string “Programming with ARM Cortex” to PC by configuring the registers of USART2. Use polling method.

9 Implementing zigbee protocol with ARM

10 Program to demonstrate I^2C Interface – Serial EEPROM

The following programs to understand the use of RTOS with ARM Processor

11 Create an application that creates two simple tasks to demonstrate the priority scheduling.

12 Write an application that creates two tasks of the same priority and sets the time slice period to illustrate time slicing.

TOTAL:45+30= 75 PERIODS

OUTCOMES:

1. Students will be able to understand ARM Architecture and its families.
2. Students will acquire knowledge on ARM Programming concepts.
3. Students can demonstrate the various Communication techniques.
4. Students can acquire knowledge on basics of Real time operating system and various processor scheduling algorithms.
5. Students will be able to design and demonstrate the embedded systems for various industrial applications.

REFERENCES:

1. ARM Systems Developer’s Guides- Designing & Optimizing System Software – Andrew N.Sloss, Dominic Symes, Chris Wright, 2008, Elsevier.
2. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes / Cole, 1999, Thomas Learning.
3. Jane.W.S. Liu, “Real-Time systems”, Pearson Education Asia, 2000.
4. Tammy Noergaard, “Embedded System Architecture, A comprehensive Guide for Engineers and Programmers”, 2nd Edition, Elsevier, 2013.
5. Shibu. K.V, “Introduction to Embedded Systems”, 2e, McGraw Hill, 2017.
6. Raj Kamal, ‘Embedded System-Architecture, Programming, Design’, McGraw Hill, 2013.
7. Wolf Wayne Hendrix, Computers as Components: Principles of Embedded Computing System Design, 3rd Edition, Morgan Kaufmann, 2012.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106105159/
2. https://www.edx.org/course/embedded-systems-shape-the-world-microcontroller-i

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. PCs with IAR Workbench and C\C++ compiler – 20 No’s
2. ARM Processor (Cortex-M4) with Interfacing – 20 No’s
3. Accessories – 20 No’s
4. Zigbee module with antenna – 20 No’s
5. PIC Universal Microcontroller (16F877A/16F84A) - 4 No’s

6. Analog CRO - 2 No’s
7. Raspberry pi 3 - 2 No’s
8. Arduino uno (ATMega328P) – 10 No’s

LIST OF INTERFACING ACCESSORIES:

1. ARM based Stepper Motor, keypad & LCD, Flashing LED, PWM, ADC and DAC
2. PIC Microcontroller based Stepper motor, Flashing LED, ADC and DAC
3. Raspberry pi 3 based Stepper motor, Flashing LED, ADC, and DAC

IR18009	INDUSTRIAL INTERNET OF THINGS	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To walk though technology timeline (brief history) and evolution of IoT
- Gain knowledge about IoT applications across various segments
- Understand IoT architecture and its building blocks
- Introduction to various IoT platforms
- Understand the technology and skills required in building and IoT product

UNIT I INTRODUCTION 8

Concepts of IoT and IIoT- Evolution of IoT, IoT architecture- Elements of IoT: Embedded systems, Micro controllers, operating system, Networking. Networking- Communication between IoT devices, Cloud based servers, Internet protocols, mobile Adhoc network ,MANET,WAN structure, Internet structure, TCP/IP application layer.

UNIT II IIOT IN MANUFACTURING PROCESSES 8

Dimensions of IIoT : Production flow monitoring , Remote equipment management, Condition-based maintenance alerts. Manufacturing operations- asset management, intelligent manufacturing. Condition-based alerts.

UNIT III IIoT IN PERFORMANCE OPTIMIZATION & MONITORING 11

Performance optimization and monitoring, planning, human machine interaction, end-to-end operational visibility and these cyber-physical systems. IoT-enabled manufacturing ecosystem, tools to plan, schedule and pro-actively service, are important differentiators.

UNIT IV IIoT FOR SAFETY AND SERVICE PROVIDERS 9

Staff safety applications, health monitoring (real-time), smart ventilation and air quality management, smart environmental measurement, access control (security). Supplier management-Vehicle and asset tracking, connected factory applications- Cyber-attacks.

UNIT V IoT PROGRAMMING 9

Micro controller programming using Ardunio platform-Building IoT applications using Raspberry Pi.

LABORATORY COMPONENT

OBJECTIVES:

To build a simple IoT application and to perform the predictive analysis on gathered data.

LIST OF EXPERIMENTS

1. Interfacing sensors with Raspberry pi or Aurdino
    - Temperature/humidity/moisture sensor
    - Proximity sensor.
    - Chemical sensors/Gas/Smoke sensors
    - IR sensors/ultrasound/Image sensors
    - Motion /Velocity/Displacement detectors
    - Accelerometer/Gyroscope sensors.
    - Acoustics /Sound/vibration.
    - Electric and magnetic sensors.
    - Force /Load/Torque/Strain/Pressure

- Leak and flow sensor.

2. IoT based Automation system using Python/Javascript.
3. Connect IOT devices through cloud using IoT protocol such as MQTT.
4. Create Wireless network of sensors using Zigbee.
5. Web based Hardware control.
6. Generating alerts for Condition based maintenance of machine.
7. Inventory/Assets tracking and management using RFID.
8. Machine status monitoring and data visualization.
9. Live emotion detection for worker safety.
10. Using Machine Learning algorithms to understand sensor data.
11. A project to be implemented covering all IoT phases using Raspberry Pi / Arduino.

TOTAL:45+30= 75 PERIODS

OUTCOMES:

1. Students will be exposed to an overview and architecture of IIoT.
2. Students will be able to do different IIoT projects using Arduino and Raspberry Pi.
3. Students will be able to identify suitable IoT technique for different industrial applications.
4. Students will be able to perform the optimization of industrial processes using IoT technique.
5. Students will be able to define the application of IoT for safety and service providers.

REFERENCES:

1. Bruce Sinclair , IoT Inc: How Your Company Can Use the Internet of Things to Win in the Outcome Economy Hardcover – May 29, 2017
2. Maciej Kranz , Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry (Old Edition) Hardcover – 30 Dec 2016.
3. Cuno Pfister ,Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects) 1st Edition, Kindle Edition
4. Robert Stackowiak , Art Licht , Venu Mantha, Louis Nagode, Big Data and The Internet of Things: Enterprise Information Architecture for A New Age 1st ed. Edition
5. Dirk Slama , Frank Puhlmann, Jim Morrish , Rishi M Bhatnagar , Enterprise IoT: Strategies and Best Practices for Connected Products and Services 1st Edition.

WEB RESOURCES:

1. https://en.wikibooks.org/wiki/I_Dream_of_IoT/Chapter_4_:_IoT_and_Cloud_Computing
2. https://pinaclsolutions.com/blog/2017/cloud-computing-and-iot
3. https://www.colocationamerica.com/blog/role-of-cloud-in-iot
4. https://www.researchgate.net/figure/IoT-Architecture-Layers-and-Components_fig1_322975901

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Raspberry Pi 3-m15 No’s.
2. Arduino UNO Board R3 (SMD) with cable-10 No’s.
3. Arduino 37 in 1 Sensor pack-3 No’s.
4. Stepper motor-5 No’s.
5. USB Keyboard & USB Mouse-15 No’s.
6. Monitor-10 No’s
7. IIoT Kit-5 No’s.
8. MQTT/COAP kit-5 No’s.
9. IoT interface board-15 No’s.
10. Sensor -10 No’s

Development Boards: Microcontroller,

1. Programmable Logic Controller (PLC)
2. IIoT Board
3. Sensors
   a. Proximity (12-36V)
   b. Vibration (SV)
   c. Temperature (3.3-5V)
   d. Colour detector(5V)
4. Actuators
   a. AC Motor(-220V)
   b. LEDs (24V.)
5. Communication interfaces: MAX485 Module
6. Basic electronic components:

Breadboard, Resistors, Relays etc.

7. Power supply boards: SMPS 24V
8. Cables & connectors
9. Setup Manuals & Software’s
10. IoT enabled Camera module

PROFESSIONAL ELECTIVE – II

IR18002	DATA ANALYTICS AND CLOUD COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To optimize business decisions and create competitive advantage with Big Data
- analytics
- To learn to analyze the big data using intelligent techniques.
- To learn the functioning of cloud computing, storage and cloud services.
- To learn about the cloud computing technology.

UNIT I INTRODUCTION TO BIG DATA AND DATA MINING 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting.

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Real time Analytics Platform (RTAP) Applications.

UNIT II HADOOP 9

History of Hadoop- the Hadoop Distributed File System – Components of Hadoop - Analyzing the Data with Hadoop- Scaling Out - Hadoop Streaming - Design of HDFS - Java interfaces to HDFS Basics- Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution.

UNIT III FRAMEWORKS 9

Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM Info Sphere Big Insights and Streams.

Predictive Analytics- Simple linear regression- Multiple linear regression- Interpretation of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications.

UNIT IV INTRODUCTION TO CLOUD COMPUTING 9

Introduction to cloud computing, From collaborative to the Cloud – A short history Client – Server Computing, Peer-to-Peer Computing, Distributed Computing, Collaborative Computing, Functioning of Cloud Computing, Cloud Architecture and Storage, Cloud Services, Industrial Applications.

UNIT V CLOUD COMPUTING TECHNOLOGY 9

Introduction-Objectives, Clients – Mobile – Thin – Thick, Security - Data Linkage - Offloading Work - Logging - Forensics - Development – Auditing, Network- Basic Public Internet- The Accelerated Internet- Optimised Internet Overlay- Site-to-Site VPN- Cloud Providers- Cloud Consumers - Pipe Size- Redundancy, Services- Identity- Integration- Mapping- Payments- Search.

TOTAL: 45 PERIODS

OUTCOMES:

1. Students will able to understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Students can acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.

3. Students can able to interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Students can define Cloud Computing and memorize the different Cloud service and deployment models.
5. Students will be able to describe importance of virtualization along with their technologies.

REFERENCES:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill Publishing, 2012.
4. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.
5. Sosinsky, “Cloud Computing Bible”, Wiley India, 2012.
6. Dan C. Marinescu, “Cloud Computing”, Morgan Kaufmann,2013.
7. Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, “Distributed and Cloud Computing”, Elsevier, 2012.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106/105/106105167/

IR18004	MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the fundamentals behind the various machine algorithms.
- To familiarize the students on important methods in ANN, Fuzzy and Genetic algorithm.

UNIT I SUPERVISED AND SEMI SUPERVISED LEARNING METHODS 10

Introduction to learning & classifiers- LDA – ANN - Naive Bayes classifier- decision tree - Regression-Ordinary Least Squares – linear and Logistic Regression- Gaussian process - Stepwise Regression - Multivariate Adaptive Regression Splines (MARS) -Locally Estimated Scatterplot Smoothing (LOESS) - overview of nearest neighbor -Support vector machines, Temporal difference learning, Q-learning

UNIT II UNSUPERVISED & REINFORCEMENT LEARNING METHODS 8

Expectation–maximization (EM) -Vector quantization, Clustering Fuzzy K &C means algorithm - Density-based spatial clustering of applications with noise (DBSCAN) -Conceptual clustering, Association rule learning -APRIORI algorithm- SVD.

UNIT III NEURAL NETWORK 9

Perceptron – Probabilistic Neural Network (PNN) - Back-Propagation (BPN) - Hopfield Network - Self-Organizing Map (SOM) - Learning Vector Quantization (LVQ)-Adaptive Resonance Theory 1 – Adaptive Resonance Theory 2 - Case studies on GA based algorithm development.

UNIT IV FUZZY CLASSIFICATION 9

Basic concepts in Fuzzy Set theory-Fuzzy logic controllers – Principles – Various industrial Applications of Fuzzy logic control – Adaptive Fuzzy systems – Fuzzy Decision making – Fuzzy classification – Fuzzy pattern Recognition – Image Processing applications – Fuzzy optimization - Case studies on fuzzy based algorithm development.

UNIT V GENETIC ALGORITHMS 9

Introduction to genetic algorithm –initialization, selection, mutation and termination-Swarm intelligence – PSO-ACO -Tabu search - Reactive search optimization (RSO)cross-entropy (CE) methods. Case studies on GA based algorithm development.

TOTAL: 45 PERIODS

OUTCOMES:

Students will

1. Gain knowledge about basic concepts of Machine Learning
2. Be able to identify machine learning techniques suitable for a given problem
3. Solve the problems using various machine learning techniques
4. Be able to apply dimensionality reduction techniques.
5. Be able to design application using machine learning techniques.

REFERENCES:

1. Ethem Alpaydin, “Introduction to Machine Learning” The MIT Press, Cambridge, London. 2nd edition, 2010.
2. Klir G.J. & Yuan Bo, “Fuzzy sets and Fuzzy Logic: Theory and Applications”, Prentice Hall of India Pvt. Ltd., 2005.
3. Laurene Fausett, “Fundamentals of Neural Networks, Architectures, Algorithms and Applications”, Prentice Hall, Englewood cliffs, 2004.

4. Randy L. Haupt, Sue Ellen Haupt Practical Genetic Algorithms, Wiley Interscience 2nd edition, 2004
5. S. Rajasekaran, GA Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, Prentice Hall of India Private Limited, 2013.
6. Simon Haykin, “Neural Networks – A comprehensive foundation”, Prentice Hall, 3rd Edition, 2004.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106106139/

IR18006 MODERN MATERIAL HANDLING SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the latest material handling system used in industry.
- To study about the concept of Automated Guided Vehicle System.

UNIT I FUNDAMENTALS OF MATERIAL HANDLING 9

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

UNIT II MATERIAL HANDLING EQUIPMENT 9

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

UNIT III AUTOMATED GUIDED VEHICLE SYSTEM 9

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

UNIT IV STORAGE SYSTEM 9

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

UNIT V ROBOTICS IN MATERIAL HANDLING 9

General considerations in robot material handling – material transfer application – pick & place operations – machine loading & unloading – characteristics of robot application.

TOTAL: 45 PERIODS

OUTCOMES:

1. Students will acquire knowledge on fundamentals of modern material handling systems.
2. Students will be able to identify different material handling equipment.
3. Students will gain knowledge on AGV
4. Students can demonstrate how storage system will be designed for modern manufacturing industries.
5. Students can apply the robotics for material handling in modern industries.

REFERENCES:

1. Mikell P. Groover, Automation Production Systems and Computer Integrated Manufacturing, PHI Learning Private Ltd, 2008.
2. Mikell P Groover, Mitchel Weiss and Ashish Dutta, Industrial Robotics, McGraw Hill Publications, 2017.
3. Material Handling Handbook, Institution of Mechanical Engg. Associate (data) Publishers P Ltd, 1996.
4. C Ray Asfahl, Robots and Manufacturing Automation, Wiley India, 2012.

WEB RESOURCES:

1. https://www.scribd.com/doc/222647028/Material-Handling-Full-Notes

IR18003	CYBER PHYSICAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To categorize the essential modeling formalisms of Cyber-Physical Systems (CPS).
- To analyze the functional behavior of CPS based on standard modeling formalisms.
- To implement specific software CPS using existing synthesis tools.
- To design CPS requirements based on operating system and hardware architecture constraints.
- To analyze and verify the correctness of CPS implementations against system requirements and timing constraints.

UNIT I INTRODUCTION TO CYBER PHYSICAL SYSTEM 6

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS Industry 4.0, AutoSAR, IIOT implications Building Automation, Medical CPS.

UNIT II PLATFORM COMPONENTS & DYNAMICAL SYSTEMS 10

CPS HW platforms - Processors, Sensors, Actuators, CPS Network - WirelessHart, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks.

Dynamical Systems and Stability Controller Design Techniques Performance under Packet drop and Noise.

UNIT III CPS IMPLEMENTATION ISSUES 10

From features to automotive software components, Mapping software components to ECUs CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion BUilding real-time networks for CPS.

UNIT IV INTELLIGENT CPS 10

Safe Reinforcement Learning - Robot motion control - Autonomous Vehicle control - Gaussian Process Learning - Smart Grid Demand Response - Building Automation

UNIT V SECURE DEPLOYMENT OF CPS 9

Secure Task mapping and Partitioning State estimation for attack detection Automotive Case study Vehicle ABS hacking Power Distribution Case study : Attacks on SmartGrids.

TOTAL: 45 PERIODS

OUTCOMES:

1. Students will be able to demonstrate the Characteristics of CPS.
2. Students will be able to identify the platform components and techniques required for CPS.
3. Students can solve the CPS implementation issues for modern industries.
4. Students can demonstrate the different control systems and their advantages of CPS.
5. Students will learn the security issues occurred while implementing the CPS in industries.

REFERENCES:

1. Edward A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems, A Cyber-Physical Systems Approach", Second Edition, MIT Press, 2017.
2. Derek Molloy, "Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux", Wiley, 2016.
3. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press.

4. Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, "Cyber-Physical Systems: From Theory to Practice", CRC Press.

WEB RESOURCES:

1. http://leeseshia.org

IR18007	HUMAN MACHINE INTERFACE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview of the concepts relating to the design of human-computer interfaces in ways making computer-based systems comprehensive, friendly and usable.
- To understand the theoretical dimensions of human factors involved in the acceptance of computer interfaces.
- Identify the various tools and techniques for interface analysis, design, and evaluation.
- Identify the impact of usable interfaces in the acceptance and performance utilization of information systems.

UNIT I INTRODUCTION TO HMI 9

HMI Basics -Human Computer Interaction as an emerging field - Applications of Human Machine Interface (HMI) - HMI types - Human Information Processing -Interaction styles and general design Interaction -strategies Interface metaphors and conceptual models HCI and the World Wide Web HCI - security Accessibility of User Interfaces Usability engineering and evaluation HCI and social computing.

UNIT II ELEMENTS OF HMI 9

HMI Interfacing Considerations -HMI Hardware Selection -HMI Software Selection Configuring System Communications - Passive and active – Mental models-Creating a Tag Database -PLC Programming Considerations -Creating Basic Graphical Displays/Screens-Security – Event controlled interface.

UNIT III PERCEPTION, MEMORY, COGNITION 9

Perception & Cognition - Visual system – image generation and perception-Touch-Hearing- Model Human Processor- STM, LTM, Chunking -Principles of Operation-Power Law - Fitts Law -Hicks Law – factors affecting -Perception, Memory, Cognition.

UNIT IV INTEGRATED MODELING FRAMEWORK 9

Supervisory control – criteria for sharing task between operator and machine - human– machine cooperation -human–machine cooperation -generic integrated modeling framework - Car driver Cognitive architecture of the human cognitive system -control loops - tactical Module – HMI in automation.

UNIT V BRAIN COMPUTER INTERFACE 9

Introduction to BCI – brain regions and responsibilities- Active methods for measuring brain activity – invasive and non-invasive procedures - EEG – P300- VEP- ERD-NIRS – Application in Prosthetic Control- Neuro rehabilitation – Neuro training – Brain controlled wheel chairs.

TOTAL: 45 PERIODS

OUTCOMES:

1. Understand the requirements of Human Machine Interface.
2. Students will be able to identify and select the components of HMI.
3. Understand the different laws pertaining to HMI.
4. Students can able to install and configure HMI hardware.
5. Students will be able to demonstrate how HMI use to control the various real time machines.

REFERENCES:

1. Allen Klinger, “Human machine interactive systems”, New York: Plenum Press, 1991.

2. Bernhard Graimann, Bredan Allison, Gert Pfurtscheller, “Brain – computer interfaces”, Springer-Verlag Berlin Heidelberg, 2010.
3. Guy A. Boyed., “The handbook of human machine interaction”, Ashgate publishing limited, England, 2011.
4. Jonathan Wolpaw, Elizabeth Winter Wolpaw,” Brain Computer Interfaces: Principles and practice”, Edition 1, Oxford University Press, USA, January 2012.
5. Jean-Yves Fiset, “Human-Machine Interface Design for Process Control Applications”, ISA Publisher, 2008.

WEB RESOURCES:

1. http://www.eng.utoledo.edu/~wevans/chap15_S.pdf

IR18011 MACHINE VISION & IMAGE PROCESSING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To review image processing techniques for machine vision
- To understand shape and region analysis
- To understand three-dimensional image and motion analysis techniques
- To study some applications of machine vision algorithms

UNIT I INTRODUCTION TO MACHINE VISION 9

Human vision – Machine vision and Computer vision – Benefits of machine vision – Block diagram and function of machine vision system implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation

UNIT II IMAGE ACQUISITION 9

Scene constraints – Lighting parameters – Lighting sources, Selection – Lighting Techniques – Types and Selection – Machine Vision Lenses and Optical Filters, Specifications and Selection– Imaging Sensors – CCD and CMOS, Specifications – Interface Architectures – Analog and Digital Cameras – Digital Camera Interfaces – Camera Computer Interfaces, Specifications and Selection – Geometrical Image formation models – Camera Calibration

UNIT III MACHINE VISION APPLICATIONS 9

Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile, applications in non-visible spectrum, metrology and gauging, OCR and OCV, vision guided robotics – Field and Service Applications – Agricultural, and Bio medical field, augmented reality, surveillance, bio-metrics.

UNIT IV INTRODUCTION & DIGITAL IMAGE FUNDAMENTALS 9

Fundamentals Steps in Digital Image Processing, Components of Digital Image Processing Systems, Applications of Digital Image Processing, Image Sampling and Quantization, Some basic relationships like Neighborhood, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations, stereo imaging and camera calibration.

UNIT V IMAGE COMPRESSION AND SEGMENTATION 9

Coding, Inter-pixel and Psycho-visual Redundancy, Image Compression models, Elements of Information Theory, Error free compression, Lossy compression, Image compression standards, Introduction to Video Coding.

Detection of Discontinuities - point, lines and edge segmentation, Edge linking and boundary detection, Thresholding, Region Oriented Segmentation. Use of Principal Components for Description, Morphological Image Processing.

TOTAL: 45 PERIODS

OUTCOMES:

1. Implement fundamental image processing techniques required for machine vision.
2. Apply chain codes and other region descriptors and implement motion related techniques.
3. Understand the rapid advances in Machine vision.
4. Learn different causes for image degradation and overview of image restoration techniques.
5. Learn different feature extraction techniques for image analysis and recognition

REFERENCES:

1. Alexander Hornberg, “Handbook of Machine Vision”, Wiley-VCH, USA, 2017

2. EmanueleTrucco & Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition, 1998.
3. Rafael C.Gonzales, Richard.E.Woods, “Digital Image Processing Publishers”, Fourth Edition, Pearson, 2008.
4. Rafael C. Gonzalez & Richard E. Woods, “Digital Image Processing”, 3rd Edition, Pearson Education, 2009.
5. A.K. Jain, “Fundamental of Digital Image Processing”, PHI, 2003.
6. Milan Sonka, Vaclav Hlavac & Roger Boyle, "Image Processing, Analysis, and Machine Vision" 3rd Edition, Cengage Learning, 2008.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106105216/
2. https://nptel.ac.in/courses/117105079/

IR18013 MANUFACTURING INFORMATION SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

- The purpose of the course is to provide an importance of databases and its application in manufacturing systems.
- To prepare students for their engineering practice by organization by conversant with order policies and data base terminologies.
- To acquire the knowledge on designing and manufacturing considerations.

UNIT I INTRODUCTION **9**

The Evolution of order policies, from MRP to MRP II to ERP – Agile Manufacturing Information Systems, Manufacturing Database Integration.

UNIT II DATABASE **9**

Terminologies – Entities and attributes – Data models, schema and subschema - Data Independence – ER Diagram – UML notation for describing the enterprise–wide data objects -Trends in database.

UNIT III DESIGNING DATABASE **9**

Hierarchical model – Network approach- Relational Database concepts, principles, keys,– functional dependency – Normalization types – relational operations- Query Languages-Case studies.

UNIT IV MANUFACTURING CONSIDERATION **9**

The product and its structure, inventory and process flow – Shop floor control Data structure and procedure – various models – the order scheduling module, Input/output analysis module, and stock status database – the complete IOM database.

UNIT V INFORMATION SYSTEM FOR MANUFACTURING **9**

Parts oriented production information system – concepts and structure – Computerized production scheduling, online production control systems, Computer based production management system, computerized manufacturing information system -RFID-Telecommunication– case study.

TOTAL: 45 PERIODS

OUTCOMES:

1. Students can apply a framework and process for aligning and organization's information technology objectives with manufacturing strategy.
2. Engineering graduate will participate in an organization's information systems and technology decision making processes.
3. Students will be able to identify ways information systems & technology may improve an organization's performance, including improving organizational processes, decision-making, collaboration, and personal productivity.
4. Students will be able to define the utilization of data base management for manufacturing activities.
5. Students define what an engineer should be able to expect from an IT department in a manufacturing organization.

REFERENCES:

1. Sartori, L.G., "Manufacturing Information Systems", Addison-Wesley Publishing Company, 1988.

2. Date C.J, ”An Introduction to Database Systems” Addison Wesley”, 8th Edition, 2003.
3. Orlicky G, “Material Requirements Planning”, McGraw-Hill, 1994.
4. Kerr R, “Knowledge based Manufacturing Management”, Addison-Wesley, 1991.
5. Oliver G and Wolfhard K, “RFID in Manufacturing”, Kubach.vwe., 2008.
6. Franjo C, “Manufacturing Information & Data Systems Analysis, Design & Practice”, Butterworth-Heinemann, 2002.
7. Weiming S, “Information Technology for Balanced Manufacturing Systems”, Springer, 2006.

WEB RESOURCES:

1. www.ist.psu.edu
2. www.cse.wustl.edu (UML Notation Guide)

IR18015 **MICRO-ELECTROMECHANICAL SYSTEMS & MICROSYSTEMS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn fundamentals of MEMS and their applications.
- To study about the techniques of miniaturization applicable for various industrial applications.
- To acquire knowledge about micromachining and micro sensors.

UNIT I OVERVIEW OF MEMS & MICROSYSTEMS 8

Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization Applications of MEMS in Industries.

UNIT II MATERIALS FOR MEMS AND MICROSYSTEMS 7

Si as substrate material, mechanical properties of Silicon, Silicon Compounds, Gallium Arsenide, Piezo-resistors, Piezoelectric crystals, Polymers, Packaging Materials.

UNIT III MEMS AND MINIATURIZATION 9

Scaling laws in miniaturization: Introduction to Scaling. Thermo Fluid Engineering: Overview of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid dynamics, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin Films.

UNIT IV MICROMACHINING PROCESSES 11

Overview of microelectronic fabrication processes used in MEMS, Bulk Micromachining – Isotropic & Anisotropic Etching, Comparison of Wet vs Dry etching, Surface Micromachining – General description, Processing in general, Mechanical Problems associated with Surface Micromachining, Introduction to LIGA process, Introduction to Bonding. Assembly of 3D MEMS - foundry process.

UNIT V MICRO SENSORS 10

Mechanical, Inertial, Biological, Chemical, Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Future Trends Micro sensors: bio, chemical, optical and thermal sensors.

TOTAL: 45 PERIODS

OUTCOMES:

1. Ability to describe MEMS fabrication technologies.
2. Capability to critically analyze microsystems technology for technical feasibility as well as practicality.
3. Mathematical formulation solution skill for modern industries.
4. Students can able to demonstrate on micro machining.
5. Students learn how to select the micro sensors for different industrial applications.

REFERENCES:

1. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, McGraw-Hill, 2002.
2. Jan Korvink and Oliver Paul, “MEMS: A Practical Guide to Design, Analysis and Applications”, 2005.
3. Ghodssi Reza, “MEMS Materials and Processes Handbook”, Springer, 2011.
4. Mohamed Gad-el-Hak, “MEMS: Introduction and Fundamentals”, Taylor and Francis, 2005.
5. Rai Choudhary P, “MEMS and MOEMS technology and applications”, PHI, New Delhi.

6. Sze S.M, Semiconductor Sensors, John Wiley & Sons, INC., 1994.

WEB RESOURCES:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/117105082/lec4.pdf

IR18017 **OPTIMIZATION TECHNIQUES** **L T P C**
3 0 0 3

OBJECTIVES:

- Introduction to optimization techniques using both linear and non-linear programming.
- After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.

UNIT I MATHEMATICAL PRELIMINARIES 7

Linear algebra and matrices - Vector space, eigen analysis - Elements of probability theory - Elementary multivariable calculus.

UNIT II LINEAR PROGRAMMING 10

Introduction to linear programming model - Simplex method – Duality - Karmarkar's method.

UNIT III UNCONSTRAINED OPTIMIZATION 10

One-dimensional search methods - Gradient-based methods - Conjugate direction and quasi-Newton methods.

UNIT IV CONSTRAINED OPTIMIZATION 9

Lagrange theorem - FONC, SONC, and SOSC conditions

UNIT V NON-LINEAR PROBLEMS 9

Non-linear constrained optimization models - KKT conditions - Projection methods

TOTAL: 45 PERIODS

OUTCOMES:

1. Students will explain the fundamental knowledge of Linear Programming and Dynamic Programming problems.
2. Use classical optimization techniques and numerical methods of optimization.
3. Describe the basics of different evolutionary algorithms.
4. Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas.
5. Students will identify the applications of various techniques of optimization.

REFERENCES:

1. Edwin P K Chong, Stainslaw Zak , “An introduction to Optimization”, WILEY, 4th edition, 2013.
2. Dimitri Bertsekas, “Nonlinear Programming”, Athena Scientific, 1999.
3. MATLAB software, Mathworks.

WEB RESOURCES:

1. http://mec.nit.ac.ir/file_part/master_doc/20149281833165301436305785.pdf

IR18019 PRODUCT DESIGN & DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To competence with a set of tools and methods for product design and development.
- To acquire confidence in your own abilities to create a new product.
- To aware the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Reinforcement of specific knowledge from other courses through practice and reflection in an action-oriented setting.

UNIT I INTRODUCTION 9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II CONCEPT GENERATION AND SELECTION 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV INDUSTRIAL DESIGN 9

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL: 45 PERIODS

OUTCOMES:

1. Identify and analyze the product design and development processes in manufacturing industry.
2. Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.

3. Analyze, evaluate and apply the methodologies for product design, development and management.
4. Undertake a methodical approach to the management of product development to satisfy customer needs.
5. Carry out cost and benefit analysis through various cost models.

REFERENCES:

1. Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International Edns. 1999.
2. Kemnneth Crow, “Concurrent Engg./Integrated Product Development”, DRM Associates, Workshop Book.
3. Stephen Rosenthal, “Effective Product Design and Development”, Business One Orwin, Homewood, 1992.
4. Staurt Pugh, “Tool Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, New york,

WEB RESOURCES:

1. https://ocw.mit.edu/courses/sloan-school-of-management/15-783j-product-design-and-development-spring-2006/lecture-notes/clas1_int_crse_6.pdf

IR18021 PRODUCT LIFE CYCLE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course provides the knowledge and practice regarding Product Life Cycle Management.
- This course gives practice through Product Life Management Strategies and Product Data Management.
- Product forecasting gives new Product Design for Manufacturing. Also, to understand the integration of PLM/PDM with other applications.

UNIT I INTRODUCTION TO PRODUCT LIFE CYCLE 9

Product life cycle – Introduction, growth, maturity & decline, Product Lifecycle Management-Definition & Overview, Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure– Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III PLM/PDM FUNCTIONS AND FEATURES 9

Case Studies based on top few commercial PLM/PDM tools. Architecture of PLM & PDM tool-PLM vs ERP integration- Agile PLM integration- PLM SCM integration.

UNIT IV ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.

TOTAL: 45 PERIODS

OUTCOMES:

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for molding, Machining, Sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant
5. Students will be able to work on customization and integration using relevant software

REFERENCES:

1. Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006.
2. Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer-Verlag, 2016.
3. Antti Saaksvuori, AnselmiImmonen, Product Life Cycle Management - Springer, 3rd Edition, 2010.
4. Clement, Jerry; Coldrick, Andy; & Sari, John. Manufacturing Data Structures, John Wiley & Sons, 1992.
5. Kari Ulrich and Steven D. Eppinger, Product Design & Development, McGraw Hill International, 6th Edition, 2015.
6. Effective Product Design and Development – by Stephen Rosenthol, Business One Orwin, Homewood, 1992.

WEB RESOURCES:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112107217/lec2.pdf

IR18023	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on design of process control by using virtual instrumentation techniques.
- To provide knowledge in process & function analysis by VI tools.

UNIT I INTRODUCTION 9

Historical perspective, advantages, blocks diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems.

UNIT II VI PROGRAMMING TECHNIQUES 9

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT III DATA ACQUISITION BASICS 9

Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

UNIT IV VI INTERFACE REQUIREMENTS 9

Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT V VI TOOLSETS 9

Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

TOTAL: 45 PERIODS

OUTCOMES:

1. To describe about virtual instrumentation.
2. Get adequate knowledge VI tool sets.
3. To describe data acquisition.
4. To get introduced to VI programming techniques.
5. To understand VI programming techniques.

REFERENCES:

1. Gary Johnson, “LabVIEW Graphical Programming”, Second edition, McGraw Hill, New York, 1997.
2. Sumathi S and Surekha P, “LabVIEW based Advanced Instrumentation Systems”, Springer.
3. Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes, 2000.
4. Lisa K. wells & Jeffrey, “LabVIEW for everyone”, Travis Prentice Hall, New Jersey, 1997.

WEB RESOURCES:

1. www.ni.com