Curriculum Structure for P.G. Programmes (M.Tech)

Automated Manufacturing Systems

SEMESTER I **Contact Hours: 26**

S. No	Course Type	Course Code	Title/Type of the Course	L	T	P	C
1	Programme Core - I	23MEAM1001	Computer Aided Modelling & Simulation	3	0	0	3
2	Programme Core - II	23MEAM1002	CNC & Part Programming	3	0	0	3
3	Programme Core - III	23MEAM1003	Micro Controllers &PLC	2	0	2	3
4	Programme Elective - I	23MEAM1014	A. Additive Manufacturing Technologies and Applications B. Hydraulic and Pneumatic systems C. Design for manufacturing and Assembly	3	0	0	3
5	Programme Elective - II	23MEAM1015	A. Artificial Intelligence for Manufacturing B. Mechatronics C. Automatic Control Systems	3	0	0	3
6	Mandatory Learning Course	23MTMC1026	Research Methodology and IPR	2	0	0	0
7	Laboratory - I	23MEAM1051	Modeling & Simulation Lab	0	0	3	1.5
8	Laboratory - II	23MEAM1052	Mechatronics Laboratory	0	0	3	1.5
9	Project	23MEAM1063	Capstone Project 1	0	0	2	1
			Total	**16**	**0**	**10**	**19**

SEMESTER II **Contact Hours: 28**

S.No	Course Type	Course Code	Title/Type of the Course	L	T	P	C
1	Programme Core – IV	23MEAM2001	Optimization Techniques	2	0	2	3
2	Programme Core – V	23MEAM2002	Computer Integrated Manufacturing	3	0	0	3
3	Programme Core – VI	23MEAM2003	Industry 4.0	3	0	0	3
4	Programme Elective – III	23MEAM2014	A. Robotics & Automation B. Computer Aided Inspection and Testing C. Computer Graphics	3	0	0	3
5	Programme Elective – IV	23MEAM2015	A. Machine Learning B. Condition Monitoring & Fault Diagnosis C. Vision System and Image Processing	3	0	0	3
6	Audit Course	23MTAC2036	Technical Report Writing	2	0	0	-
7	Laboratory - I	23MEAM2051	CAM Laboratory	0	0	3	1.5
8	Laboratory - II	23MEAM2052	Robotics laboratory	0	0	3	1.5
9	Project	23MEAM2063	Capstone Project 2	0	0	2	1
10	Term Paper	23MEAM2064	Term Paper [2]	2	0	0	1
			Total	**18**	**0**	**10**	**20**

Semester III **Contact Hours:23**

S.No	Course Type	Course code	Title/Type of the Course	L	T	P	C
1	Programme Elective - V	23MEAM3011	Students to complete course in any MOOCS Platform such as NPTEL	3	0	0	3
2	Project (Part-A)	23MEAM3061	Dissertation/ Industrial Project	0	0	20	10
3	Internship	23MEAM3052	Internship/Summer Training in Research Organizations/ Institutions of Higher Learning (After II Sem)	0	0	0	2
			Total	**3**	**0**	**20**	**15**

Semester IV **Contact Hours:32**

S.No	Course Type	Course code	Title/Type of the Course	L	T	P	C
1	Project (Part-B)	23MEAM4061	Dissertation/ Industrial Project	0	0	32	16
			Total	**0**	**0**	**32**	**16**

Semester	Credits
1	**19**
2	**20**
3	**15**
4	**16**
Total	**70**

L – Lecture, T – Tutorial, P – Practical, C – Credits

Note:

1. Student has to prepare a project applying the knowledge and hands on technical skills they have gained through course work and lab sessions in **semester-1** under **capstone Project 1**
2. Student should carry out literature survey of the selected problem and present it in a Seminar for the yearlong Project Work under Term Paper.
3. Student has to carry out a project applying the knowledge and hands on technical skills they have gained through course work and lab sessions in semester-2 under **capstone Project 2.**
4. At least theory course in **I&II** semesters can be made as integrated course (Theory coupled with Laboratory).
5. Maximum of three theory courses (40% of courses) can be offered as self-learning courses in each of the First and Second semesters.

23MEAM1001: COMPUTER AIDED MODELING AND SIMULATION

Course Category: Programme Core	Credits:3
Course Type: Theory	Lecture-Tutorial-Practice:3-0-0
Prerequisites: Computer Graphics Mathematics for Mechanical Engineers	Continuous Evaluation:40 Semester End Evaluation:60 Total Marks:100

Course Outcomes

Upon successful Completion of the course, the student will be able to:

CO1: Learn the features of CAD, Transformations and Geometric modeling.
CO2: Implement algorithms and parametric equations to generate complex surfaces.
CO3: Optimize the assembly process through various assembly sequences.
CO4: Analyze principles of simulation and algorithm of discrete and continuous systems.

Course Contents

UNIT I

Introduction to CAD: Fundamentals of CAD, Applications of computer for design, Benefits of CAD, Transformations (translation, rotation, scaling & mirror) Homogeneous representation of transformations, Concatenation of transformations.
Geometric Modeling: Generation of Parametric equations of line, circle, ellipse, cubic spline, Bezier curve, B-Spline curve.

UNIT II

Parametric equations of Surfaces: Bezier surface, B-spline surface, surfaces of revolutions, ruled surface, tabulated cylinder. **Visual Realism:** Introduction, Hidden line removal algorithm - the priority algorithm, advantages & applications.
Hidden surface algorithm: z-buffer algorithm, advantages & applications, shading techniques: Gourand shading & Phong shading, applications, Coloring techniques.

UNIT III

Assembly of Parts: Introduction, assembly modeling: part modeling representation, Hierarchical relationship, mating conditions; Generation of assembly sequences.
Precedence diagram: assembly tree, representation in Precedence diagram and Liaison sequence analysis: Liaison diagram, Liaison graph generation for various case studies - Electric motor clutch assembly, House hold fan assembly, Screw jack assembly, Electric bell assembly.

UNIT IV

Introduction Simulation: tool, advantages and disadvantages of simulation, areas of application, systems and system environment, components of a system, discrete and continuous systems.

General Principles Concepts in discrete event simulation, time advance algorithm, manual simulation using event scheduling, basis properties and operations.

Text Books:

1. CAD/CAM – Theory & Practice, Ibrahim Zied, Mc Graw Hill, International edition, 2017.
2. CAD/CAM, Mikel P Groover & W Zimmers Jr, Pearson Education, India, 5th impression 2015
3. CAD/CAM concepts & applications, Chennakesava R. Alavala,(PHI), 2009
4. Simulation Modelling and Analysis by Law and Kelton, Mc Graw Hill, 1991

Reference Books:

1. CAD/CAM, P.N.Rao, Tata McGraw Hill, 6th reprint, 2006
2. Procedural elements for Computer Graphics by Rogers, Tata McGraw Hill, 2005
3. Principles of Interactive Graphics by Newman and Sproull, Tata McGraw Hill, 2009.
4. Simulation Model Design& execution by Fishwich, Prentice Hall, 1995.

Web Resources:

1. https://egyankosh.ac.in/bitstream/123456789/26973/1/Unit-4.pdf.
2. Z-Buffer or Depth-Buffer method - GeeksforGeeks.
3. https://www.tandfonline.com/doi/full/10.1080/0951192X.2015.1130260
4. https://cs.wmich.edu/alfuqaha/Spring10/cs6910/lectures/Chapter1.pdf

Designation	Name in Capitals	Signature with Date
Course Coordinator	Dr. B. SUPRAJA REDDY	
Program Coordinator	Dr. Ch. NAGARAJU	
Head of the Department	Dr. N. VIJAYA SAI	

23MEAM1002: CNC & PART PROGRAMMING

Course Category: Programme core — Credits:3
Course Type: Theory — Lecture-Tutorial-Practice:3-0-0
Prerequisites: CAM, Machine Tools. — Continuous Evaluation:40
Semester End Evaluation:60
Total Marks:100

Course Outcomes

Upon successful Completion of the course, the student will be able to:

CO1: Understand the features of NC, CNC & DNC and Machine control unit.
CO2: Develop manual part programme for machining components.
CO3: Develop the concepts of Group Technology and Computer Aided Process Planning.
CO4: Analyze principles of APT programming and adaptive control machining system.

Course Contents

UNIT I

Introduction: Fundamentals of numerical control Systems, classification, advantages and Limitations of NC systems, point to point and contouring NC systems, incremental and absolute systems.
Machine control unit: Functions of MCU, MCU organization.
CNC and DNC: Introduction, limitations of conventional NC, principles of operation of CNC, features of CNC, advantages of CNC, Direct numerical control: Types, Functions advantages and limitations of DNC.

UNIT II

NC Part Programming: Introduction, NC coordinate system, Manual part programming, Codes and concepts, types of tape formats, Tool Length and radius compensation, point to point and contour programming examples.
NC Part Programming (Contd.): Canned cycles, Subroutines, MACROS, simple problems of Drilling, Turning and two-dimensional Milling.

UNIT III

Group Technology: Introduction, Part Families, Parts Classification and Coding, Different parts classification and coding systems, Cellular Manufacturing, Composite Part Concept, Benefits of Group Technology.

Computer Aided Process Planning: Types of Computer Aided Process Planning, Retrieval type of Process Planning Systems, Generative Process Planning Systems, Benefits of CAPP.

UNIT IV

Computer Aided Part Programming: NC language: APT. Preprocessor, Post processor, advantages of computer aided programming, APT programming, Geometric statements, motion statements, additional APT statements, simple problems of APT programming. **Adaptive Control:** Adaptive Control machining systems, types, benefits of Adaptive control systems.

Text Books:

1. CAD/CAM – M.P.Groover & E.W.Zimmers, Pearson, Eleventh impression, 2012.
2. Computer Control of Manufacturing Systems - Y. Koren, Tata McGraw Hill, Eight reprint, 2012.

Reference Books:

1. Automation, Production Systems and CIM – M.P.Groover , Pearson, Fourth Edition, Second impression, 2017.
2. "CAD / CAM "– PN Rao (PHI)3rd Edition, 2010.
3. Numerical Control & Computer Aided Manufacturing – T.K.Kundra, P N.Rao &N.K.Tewari, Tata McGraw-Hill.
4. Computer Aided Manufacturing – T.K.Kundra, P.N.Rao& N.K. Tiwari, McGraw Hill, Ist edition, 22 reprint, 2014.

Web resources:

1. http://www.technologystudent.com/cam/cncman4.htm
2. http://www.cnccookbook.com/CCCNCMachine.htm
3. https://www.cncci.com/resources/articles/what%20is%20cnc.htm

23MEAM1003: MICROCONTROLLERS AND PLC

Course Category: Program Core | Credits: 3
Course Type: Theory | Lecture-Tutorial-Practice: 2-0-2
Continuous Evaluation: 40 | Semester end Evaluation: 60
Prerequisites: Basic electrical and Electronics Engineering | Total Marks: 100

Course Outcomes:

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

CO1: Recognize the basics of microcontroller and microcontroller architecture
CO2: Classify the various microcontroller hardware components and its applications.
CO3: Comprehend the function of Programmable Logic Controllers (PLCs) in the context of Industrial Automation.
CO4: Acquire knowledge about the fundamental aspects of PLC installation practices, operational safety for PLC and examine practical case studies of their applications.

Course Content

UNIT I

Microcontroller Basics: Microprocessor systems, Microcontrollers, Difference between Microprocessor and Microcontroller, Selection of microcontroller, 8-bit and 16-bit Microcontrollers, CISC and RISC processors, Harvard and VON Neumann architectures, 8051 Microcontroller architecture – Memory organization, Special Function Registers (SFR), External memory access, Counters and Timers, Pin configuration of 8051 Microcontroller.

UNIT II

Interfacing and Applications of Microcontrollers: Introduction, light emitting diodes, pushbuttons, relays, latch connections, keyboard interfacing, interfacing 7-segment displays, Analog-to-Digital converter, Digital-Analog converter. Measurement applications - sensing robot arm position, Optical Rotary shaft Encoders, angular speed measurement, Automobile and Control Applications – Digital PID controller.

UNIT III

Programmable Logic Controllers (PLC): Introduction, Parts of PLC, PLC Verses Computers, PLC size and application, Basic PLC structure, Input/ Output processing, ladder programming, Instruction lists, Latching and internal relays, sequencing, Timers and counters, Shift registers, master and jump controls, Data handling, analogue input/output.

UNIT IV

PLC installation practices: PLC enclosures, Electrical Noise, Leaky input and output, grounding, voltage variations and surges, program editing, programming and monitoring, preventive maintenance, troubleshooting.

Case studies: Raising and lowering a car parking barrier, microcontroller for control solenoid valves of the pick and place robot unit, control the level of water in a storage tank.

Text Books:

1. "Microcontrollers: Theory and Applications", Ajay V Deshmukh, McGraw Hill education India Pvt. Ltd, 2017.
2. "Microcontrollers and Applications", Dr. Ramani Kalpathi and Ganesh Raja, Sanguine Technical Publishers, Bangalore, 2007.
3. "Mechatronics - Electronic control systems in mechanical and electrical engineering" Sixth Edition, William Bolton, Pearson, 2015.
4. Programmable Logic Controller", Frank D. Petruzella, McGraw-Hill education India Pvt. Ltd, 2010.

Reference books:

1. "The 8051 Microcontroller and Embedded Systems using Assembly and C", Muhammad A. Mazidi, Jannice G Mazidi, Rolin D McKinlay, 2nd Edition., PHI, 2013.
2. "Microprocessor Architecture, Programming and Applications with the 8085", Ramesh Gaonkar, 6th edition, Penram International Publishing India Pvt. Ltd., 2013.

Web resources:

1. Nptel Web course on Microcontrollers and Applications by Dr. S. P. Das, IIT Kanpur. https://nptel.ac.in/courses/117/104/117104072/
2. Nptel Web course on Microprocessors and Microcontrollers by Dr. Santanu Chattopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/108105102

23MEAM1014A: ADDITIVE MANUFACTURING TECHNOLOGIES AND APPLICATIONS

Course Category: Programme Core — Credits: 3
Course Type: Theory — Lecture-Tutorial-Practice: 3-0-0
Prerequisites: Manufacturing Processes, CAD — Continuous Evaluation: 40
Semester End Evaluation: 60
Total Marks: 100

Course Outcomes

At the End of the course the student will be able to:
CO1: Recognize the importance and need of AM in manufacturing.
CO2: Understand various Liquid and Solid AM Processes.
CO3: Understand Powder based AM Processes and Rapid Tooling
CO4: Analyze AM Data Format, Software and applications in various domains.

Course Content

UNIT I

Introduction to Additive Manufacturing Techniques: Introduction, Prototyping fundamentals-Definition, Types and roles of Prototypes, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms.

Additive Manufacturing: Classification of AM process, Fundamental Automated Processes, Process chain, Distinction between AM and CNC other related technologies.

UNIT II

Liquid Based Additive Manufacturing: Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Poly jet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

Solid-Based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

UNIT III

Powder Based Rapid Proto Typing Systems and Tooling: Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications,

Advantages and Disadvantages. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. **Rapid Tooling:** Classification and Definition of terms, Properties of AM tools, Indirect Rapid Tooling Processes, Direct Rapid Tooling Processes.

UNIT IV

Additive Manufacturing Data Format And Software: STL format, Slicing Algorithms STL File Problems, Consequences of Building Valid and Invalid Tessellated Models, STL File Repair

Additive Manufacturing Applications: Applications in Design, Engineering, Analysis and Planning, Manufacturing and Tooling, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, Arts and Architecture

Text Books:

1. Chua C.K., Leong K.F, LIMC.S, ―Rapid Prototyping: Principles and Applications‖, World Scientific publications, 3rd Edition, 2010.

Reference Books:

1. Andreas Gebhardt, Jan-Steffen Hötter ― Additive Manufacturing 3D Printing for Prototyping and Manufacturing" Hanser Publications, Cincinnati. 2016.
2. Paul F Jacobs, ―Rapid Prototyping& Manufacturing‖, Wohlers Associates, 2000 ASME Press, 1st Edition, 1996.
3. D.T Pham, S. S. Dimov, ―Rapid Manufacturing‖, Springer, 1st Edition, 2001.

Web References:

1. http://nptel.ac.in/courses/112107077/38
2. http://web.iitd.ac.in/~pmpandey/MEL120_html/RP_document.pdf

23MEAM1014B: HYDRAULICS AND PNEUMATIC SYSTEMS

Course Category: Programme Elective I — Credits:3
Course Type : Theory — Lecture/Tutorial/ Practice: 3-0-0
Prerequisites : Fluid Mechanics — Continuous Evaluation: 40
Semester end Evaluation: 60
Total Marks: 100

Course Outcomes

Upon successful Completion of the course, the student will be able to:

CO1: Understand the working Principles of Hydraulic pump and actuators

CO2: Illustrate the working of different Control valves and Hydraulic Circuits

CO3: Apply basic Principles to applications of Pneumatic Systems

CO4: Identify faults in the hydraulic systems and maintenance of the hydraulic system.

Course Content

UNIT I

Introduction: Fluid Power, Basic Law, Application of Fluid Power, Advantages of Fluid Power Systems, Types of Fluid Power Systems.

Hydraulic Systems: Pumps – Gear Pumps, Vane Pumps Piston Pumps. Selection and Specification of Pumps.

Hydraulic Actuators: Linear and Rotary Actuators

UNIT II

Control and Regulation Elements: Pressure, Flow and Direction Control Valves

Hydraulic Circuits: Reciprocation, Quick Return, Sequencing, Synchronizing Circuits, Industrial Circuits - Punching Press Circuit, Milling Machine Circuits

UNIT III

Introduction to Pneumatic Systems: Pneumatic fundamentals, Pneumatic Valves

Pneumatic Circuits: Pneumatic circuits- Basic pneumatic circuit, Quick exhaust circuit, feed control circuit and Time delay circuit.

UNIT IV

Hydraulic Circuits: Accumulators, Accumulator Circuits – Leakage Compensation, Auxiliary Power Source, Emergency Source of Power

Maintenance of Hydraulic Systems: Maintenance of Hydraulic Systems, Trouble Shooting of Hydraulic System.

Low cost automation: Concepts of Low Cost Automation. Technologies used for Low Cost Automation.

Text Books:

1. Antony Espossito, "Fluid power with Applications", Prentice Hall, 1980

2. R Srinivasulu, “Hydraulic Pneumatic Controls”, 2nd edition, TMH, 2009.

Reference books:

1. Andrew Parr, "Hydraulics and Pneumatics", (HB), Jaico Publishing House, 1999
2. Bolton. W. "Pneumatic and Hydraulic systems", Butterworth - Heinneman, 1997

Web resources:

1. http://www.efluids.com/
2. http://fluid.power.net/
3. www.hydraulicspneumatics.com/
4. www.waterengr.com/
5. www.pumps.org/

23MEAM1014C: DESIGN FOR MANUFACTURING AND ASSEMBLY

Course Category: Programme Elective I
Course Type: Theory
Prerequisites: Manufacturing Processes
Engineering Design

Credits:3
Lecture-Tutorial-Practice:3-0-0
Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes

At the end of the course the student will be able to:

CO1: Understand the basic concept of DFMA for economical production and select the Materials.
CO2: Apply the knowledge in the field of metal casting.
CO3: Understand and apply the machining and forming considerations in Design for Manufacturing.
CO4: Apply the design considerations in joining and integrate the knowledge of compliance analysis, interference analysis and environmental guidelines for assembly.

Course Content

UNIT I

Introduction to DFMA: History of DFMA, Steps for applying DFMA during product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA,

Introduction to Manufacturing Process: Classification of manufacturing process, Basic manufacturing processes,

Introduction to materials: Introduction, Mechanical properties of materials, material selection: Classification of engineering materials, Material selection for product design

UNIT II

DFM methodology: Sand casting: Typical characteristics of sand cast part, Design recommendation for sand casting, Die casting: Suitable material consideration, General design consideration, Specific design recommendation. Powder metal processing: Typical characteristics, Design recommendations.

UNIT III

DFM methodology: Machining: Recommended materials for machinability, Design recommendations, turning operation: Suitable materials, Design recommendations,

DFM methodology: Forging: Forging processes, Forging nomenclature, Suitable materials for forging, Design recommendations, Extrusion: Process, Suitable material for extrusion, Design recommendation for metal extrusion. Rolled Section: Process, Design recommendations of rolled section,

UNIT IV

DFM methodology: Welding:Review of welding Processes,design recommendation for welding process, Solder and brazed assembly: Process, Typical characteristics, Suitable materials, Design detail recommendations, Adhesively bonded assemblies: Typical characteristics, Suitable materials, Design recommendations for adhesive joint

Assembly: Compliance analysis and interference analysis for the design of assembly –design and development of features for automatic assembly –liaison diagrams. Environment: Motivations for environment, principles of environment-eco-efficiency, PLM perspective, environment tools and processes, environment design guidelines

Text Books:

1. L. C. Schmidt, G. Dieter, Engineering Design, 4thedition, McGraw Hill Education India Private Limited.
2. James G. Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Co., 2nd edition1986.
3. Robert Matousek., Engineering Design - A Systematic Approach, Blackie & Sons Ltd, 1963.
4. P.Dewhurst, W.Knight, G.Boothroyd, Product Design for Manufacture and Assembly, CRC Press.

Reference Books:

1. A K Chitale and R C Gupta, "Product Design and Manufacturing", PHI, New Delhi,
2. J. Lesko, Industrial Design, Materials and Manufacture Guide, John Willy and Sons, Inc
3. O. Molloy, S. Tilley and E.A. Warman Design for Manufacturing and assembly, Chapman &Hall, London, UK.
4. D. E. Whitney, Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development, Oxford University Press, New York

Web Resources:

1. http://www.npd-solutions.com
2. http://www.slideshare.net
3. http://poeth.com
4. http://hubpages.com
5. www.sciencedirect.com
6. http://soa.asee.org

23MEAM1015A: ARTIFICIAL INTELLIGENCE FOR MANUFACTURING

Course Category: Programme Elective II — Credits : 3
Course Type : Theory — Lecture-Tutorial-Practice: 3-0-0
Prerequisites : Manufacturing Processes — Continuous Evaluation: 40
Semester end Evaluation: 60
Total Marks: 100

Course Outcomes:

Upon successful Completion of the course, the student will be able to:

CO1: Understand the principles of Modern Manufacturing and AI Based Applications
CO2: Understand AI based Methods for Process Control & Monitoring
CO3: Understand AI based Design Space Exploration
CO4: Apply AI Methods for Process Control & Monitoring to Case Studies

Course Content

UNIT I

Introduction to Modern Manufacturing and AI Based Applications: Introduction to Modern Manufacturing Process, Industry 4.0, Introduction to AI and its applications in manufacturing, Design in Manufacturing and AI Requirements

UNIT II

AI based Methods for Process Control & Monitoring: Machine Learning methods, AI based Monitoring and control of discrete manufacturing process, online process monitoring in additive manufacturing, Industrial Machine Vision, Development of Digital Twins

UNIT III

AI based Design Space Exploration: Multiobjective heuristic search for DSE, Algorithms for Customizable Manufacturing: Allocation and Layout, Scheduling for flexible manufacturing systems

UNIT IV

Case studies: Process Monitoring - Friction stir welding, Additive Manufacturing with metal 3D printing using Laser Powder Bed Fusion, Digital twin of hydraulic pack, AI in quality assurance

Text books:

1. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd Edition, Prentice Hall, 2009.
2. Deep Learning - Ian Good fellow, Yoshua Bengio, Aaron Courville, MIT Press, 2018

Reference books:

1. Additive manufacturing of Metals: The Technology, Materials, Design and Production; Ed. Li Yang, et al.; Springer International Publishing AG 2017
2. Laser Materials Processing, by W M Steen, J. Mazumder, 4th Ed. Springer

Web resource:

https://youtu.be/c-MpLg148QE

23MEAM1015B: MECHATRONICS

Course Category: Programme Elective II | Credits:3
Course Type: Theory | Lecture-Tutorial-Practice:3-0-0
Prerequisites: PLC | Continuous Evaluation:40
Semester End Evaluation:60
Total Marks:100

Course Outcomes

At the End of the course the student will be able to

CO1: Acquire knowledge about microprocessors and its need.
CO2: Understand the internal architecture of 8086 microprocessor and micro controllers.
CO3: Know the working of actuators.
CO4: Design the mechatronics system

Course Content

UNIT - I

Introduction: Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design.
Microprocessor and micro controllers: General definitions of microprocessors and micro controllers, Similarities and Dissimilarities of Microprocessors and microcontrollers. interfacing of microprocessors with RAMs, ROMs. Introduction to peripheral interfacing.

UNIT II

INTEL 8086 Microprocessor: Pin Functions, Architecture, Characteristics and Basic Features of Family.
Microcontroller: Introduction to Microcontrollers, Evolution, Basic structure, input/output processing, Mnemonics, Timers, Internal relays and counters. Data handling- Analog input/ output, D/A Converters and A/D Converters, Selection of PLC.

UNIT III

Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety etc.
Classification of Actuators: Linear actuators, Rotary actuators, Actuators to operate flow control valves, Selection of mechano-electrical actuators: DC motors, Stepper Motors, Solenoid Actuators, Servo Motors.

UNIT IV

Sensors and Transducers: Introduction-Performance terminology static and dynamic characteristics, Displacement position and proximity- strain gauged element, capacitive element, Differential transformers, Optical encoders, Proximity switches. Velocity and Motion- Tachogenerator, pyroelectric sensors. Temperature sensors – RTDs, Thermisters, thermocouples. Light sensors, Selection of sensors.
Mechatronics Design: Designing, Possible design solutions- wiper mechanism, Pick and place robot, Car park barrier, Traffic light controller and Tank level control system.

Text books:

1. Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering, Bolton. W, Pearson Education, 5th Edition.
2. Douglas V Hall, Microprocessors & Interfacing, 2nd Edition, TMH.

Reference Books:

1. Mechatronics by HMT,1st Edition. Mechatronics by Mahalik,1st Edition,
2. TMH. Introduction to Mechatronics –David and Alcaitore Michael B.Histand TMH,

Web Resources:

1. http://www.engr.sjsu.edu/sjlee/vEndors.html
2. www.engr.colostate.edu/~dga/mechatronics/resources.html
3. www.NI.com
4. www.cambridgemechatronics.com/contact/terms
5. www.pdf-free-download.com/mechatronicslabs.pdf6.mechatronics.me.wisc.edu

23MEAM1015C: AUTOMATIC CONTROL SYSTEMS

Course Category: Programme Elective II — Credits:3
Course Type: Theory — Lecture-Tutorial-Practice:3-0-0
Prerequisites: Mathematics, Computer Aided Manufacturing, MATLAB — Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes

At the end of the course the student will be able to:
CO1: Describe the basic elements of control system
CO2: Illustrate time domain analysis to control systems
CO3: Interpret frequency domain analysis to control systems
CO4: Produce the state space analysis to control systems

UNIT I

Introduction : Components of Automatic control systems- Open loop and closed loop systems - Examples - Transfer function - Modeling of physical systems - Mechanical Systems - Translational and Rotational systems - Hydraulic systems and Electrical Systems - Transfer function of DC servomotor - AC servomotor - Block diagram - reduction techniques - Signal flow graph - Mason's gain formula.

UNIT II

Time Domain Analysis : Continuous time signals - Standard Test signals - Classification of continuous time systems - Linear- Nonlinear - Time variant - Time invariant - Static - Dynamic - Time response of second order system - Time domain specifications - Types of systems - Steady state error constants -Generalized error series - Introduction to P, PI and PID modes of feedback control. - Introduction to lead, lag and lead-lag compensators

UNIT III

Frequency Domain Analysis: Frequency domain specifications - Estimation for second order systems- Correlation between time and frequency domain specifications for second order systems - . Bode plot – Determination of Transfer Function from Bode plot - All pass minimum phase and non-minimum phase systems - Polar plot - Determination of gain and phase Margins from the plots.

UNIT IV

State Space Analysis : Limitations of conventional control theory - Concepts of state, state variables and state model - state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables - State equations - Transfer function from the State model - Solutions of the state equations -State Transition Matrix - Concepts of controllability and observability.

Text Books:

1. Smarajit Ghosh, "Control Systems Theory and Applications", 2 nd Edition, Pearson Education, New Delhi, 2012.
2. Ogata K, "Modern Control Engineering", 5 th Edition, Pearson Education, New Delhi, 2009.

References:

1. Nagrath I J, Gopal M, "Control Systems Engineering", 5 th Edition, Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf , Robert H Bishop , "Modern Control Systems", 12th Edition, Addison-Wesley, New Delhi, 2010.

3. Norman S Nise, "Control System Engineering", 6 th Edition, John Wiley & Sons, Singapore, 2012.
4. S Palani, "Control Systems Engineering", 2nd Edition, McGraw Hill Education Pvt. Ltd, New Delhi, 2010.

Web Resources:

1. https://www.mathworks.com/content/dam/mathworks/mathworks-dot com/solutions/automotive/files/in-expo-2012/introduction-to-control-systems-design-and-analysis-using-matlab-and-simulink.pdf
2. https://www.researchgate.net/publication/317497952_Introduction_to_Control_Systems_Design_Using_Matlab
3. https://nanopdf.com/download/ecen-4413-automatic-control-systems-matlab-lecture-1_pdf

23MTMC1026: RESEARCH METHODOLOGY AND IPR

Course Category: Mandatory Learning Course | Credits:0
Course Type: Theory | Lecture-Tutorial-Practice:2-0-0
Prerequisites: | Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes
Upon successful Completion of the course, the student will be able to:

CO1: Acquire an overview of the research methodology and techniques to define research problem.
CO2: Review the literature and identify the problem.
CO3: Analyze the optimum sampling techniques for collected data.
CO4: Apply various forms of the intellectual properties for research work.

Course Contents

UNIT I

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Research Approaches, Significance of Research, Research and Scientific Methods, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Research Problem: Defining the Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, an Illustration.

UNIT II

Reviewing the literature: Place of the literature review in research, improving research methodology, broadening knowledge base in research area, enabling contextual findings.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Basic Principles of experimental Designs, Important Experimental Designs.

UNIT III

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, sources of error in measurement tools.
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Testing of Hypotheses: Hypothesis, Basic Concepts, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing.

UNIT IV

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, and Significance of Report Writing.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act, 1957, Trade Secrets, Utility Models WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement.

Text Books:

1. Research methodology: Methods and Techniques, C.R. Kothari, GauravGarg, New Age International, 4th Edition, 2018.
2. Research Methodology a step-by-step guide for beginners. Ranjit Kumar, SAGE Publications Ltd.,3rd Edition, 2011.
3. Study Material, Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body under an Act of Parliament, September 2013.

Reference Books:

1. An introduction to Research Methodology, Garg B.L et al ,RBSA Publishers 2002
2. An Introduction to Multivariate Statistical Analysis Anderson T.W, Wiley 3rd Edition,
3. Research Methodology, Sinha, S.C, Dhiman, EssEss Publications2002
4. Research Methods: the concise knowledge base ,Trochim ,Atomic Dog Publishing ,2005
5. How to Write and Publish a Scientific Paper, Day R.A, Cambridge University Press 1992.
6. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009
7. Proposal Writing, Coley S.M. Scheinberg, C.A, Sage Publications, 1990
8. Intellectual Property Rights in the Global Economy, Keith Eugene Maskus, Institute for International Economics.

23MEAM1051 MODELING AND SIMULATION LABORATARY

Course Category: Programme Core — Credits:1.5
Course Type: Laboratory — Lecture-Tutorial-Practice:0-0-3
Prerequisites: Engineering graphics, Machine Design FEM — Continuous Evaluation:40
Semester End Evaluation:60
Total Marks:100

Course Outcomes:

Upon successful Completion of the course, the student will be able to:

CO1: Generate geometrical part models and assemblies of machine components.
CO2: Generate Surface models of machine components.
CO3: Simulate static, dynamic and buckling analysis of engineering problems using FEA software.
CO4: Simulate static analysis of composite structures using FEA software.

Course Contents

1. Part modelling with simple & moderate features.
2. Part & surface modelling with advance features.
3. Assembly of solid model parts & verification for interface tolerances.
4. Static Analysis.
5. Dynamic Analysis.
6. Buckling Analysis.
7. Analysis of Composite Structures.

Text Books:

1. CATIA V5R20 for Designers - Sham Tickoo, Publications - Purdue University Calumet and CADCIM Technologies, USA Published by CADCIM Technologies, USA - ISBN: 978-1- 932709-94-0.
2. Finite Element Analysis using ANSYS 11.0 - Paleti Srinivas, published by PHI Learning Private Limited, New Delhi, 2013.

Reference Book:

1. CAD/CAM: Theory & Practice (Theory and Practice), Zeid Ibrahim, Tata Mc-Graw hill publication.

Web resources:

1. https://www.youtube.com/watch?v=srnm--IKtl4
2. https://catiatutor.com/
3. https://www.youtube.com/watch?v=BDHdcSzKhxk
4. https://www.youtube.com/results?search_query=project+2d+sketches+with+bill+of+materials
5. http://www.mece.ualberta.ca/tutorials/ansys/

23MEAM1052: MECHATRONICS LABORATORY

Course Category: Program core — Credits:1.5
Course Type : Laboratory — Lecture-Tutorial-Practice:0-0-3
Prerequisites : Microcontroller and PLCs — Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes:

Upon successful Completion of the course, the student will be able to:

CO1: Acquire a concepts and importance of Modular Automated Production System (MAPS) and logic gates.
CO2: Create PLC ladder programs for simple tasks.
CO3: Apply timers, counters and comparators commands using PLC
CO4: Operate MAPS system as an integrated flexible manufacturing system.

Course content

Lab Exercises:

1. Understand Modular Automated Production System (MAPS) and use of sensors, controller and communication related issues.
2. Study of PLC programming Language viz. STEP-7 Basic (TIA portal) V13.0
3. Implementation of logic gates viz. OR, AND, NOR, NAND etc. through PLCs.
4. Control of a single acting cylinder using a Solenoid valve through PLC.
5. Ladder programming for accomplishing rotary pick and place task.
6. Use timers to regulate the rotary pick and place task.
7. Use ladder program to perform sorting based on object height.
8. Use ladder program to perform sorting based on object material type.
9. Develop programs to index a rotary table for accomplishing automatic bottle filling.
10. Execute ladder program to regulate actuation of conveyor belt.
11. Understand fault identification and troubleshooting in automation through MAPS.
12. Demonstrate working of the MAPS system as an integrated flexible manufacturing system.

Text books:

1. Mechatronics Electronic control systems in Mechanical and Electrical Engineering by W. Bolton, PEARSON, 4th Edition, 2011.
2. Introduction to Mechatronics – David and Alcaitore Michael B.Histand TMH,

4th Edition, 2006.

Reference Book:

1. E.O. Deobelin, “Measurement Systems –Application and Design”, Tata McGraw Hill, 2004.
2. H S Kalsi, “Electronic Instrumentation”, 2nd Edition, Tata McGraw Hill
3. A Barua, “Fundamentals of Industrial Instrumentation”, Wiley India, 2011.

E-resources and other digital material:

Resources:

[1] https://www.mechatronics.colostate.edu/
[2] https://eil-iitg.vlabs.ac.in/
[3] https://www.researchgate.net/publication/310239627_Mechatronics_Lab_Manual_ME_6712
[4] www.NI.com

Video references:

[1] https://www.youtube.com/watch?v=o4_NeqlJgOs
[2] https://www.youtube.com/watch?v=0cpSi8C95DY
[3] https://www.youtube.com/watch?v=Hx33qw-z_cQ
[4] https://www.youtube.com/watch?v=ZApY8wwWPpg
[5] https://www.youtube.com/watch?v=19aGHGMOx1w

23MEAM1063: CAPSTONE PROJECT 1

Course Category: Capstone Project
Course Type: Project
Prerequisites:

Credits:1
Lecture-Tutorial-Practice: 0-0-2
Continuous Evaluation: 40
Semester End Evaluation: 60
Total Marks: 100

Course Outcomes

Upon successful Completion of the course, the student will be able to:

CO1: Identify relevant experiences to academic knowledge from different courses

CO2: Make use of connections across disciplines, perspectives, fields of study;

CO3: Adopt and apply information to new situations;

CO4: Compile in meaningful self-reflection.

23MEAM2001: OPTIMIZATION TECHNIQUES

Course Category:	Programme Core	Credits:3
Course Type:	Theory	Lecture-Tutorial-Practice:2-0-2
Prerequisites:	Operation Research, Algorithms	Continuous Evaluation:40
		Semester end Evaluation:60
		Total Marks:100

Course Outcomes

At the end of the course the student will be able to:

CO1: Understand the different classical and numerical Optimization techniques.
CO2: Acquire the knowledge of Neural Networks and back propagation networks.
CO3: Understand the principles of Genetic Algorithms.
CO4: Apply fuzzy systems for optimization in design and manufacturing systems.

Course Content

UNIT I

Classical Optimization Techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

Numerical Methods for Optimization: Interval halving method, Fibonacci method, Quadratic interpolation method, Newton method, Quasi Newton method, Secant method.

UNIT II

Introduction to Neural networks: Basic Concepts of Neural Networks, Human Brain, Model of an Artificial Neuron, Neural Network Architectures – Single layer feed forward Network; Multilayer feed forward Network, Recurrent Networks. Characteristics of Neural Networks, Neural Network Architecture – Rosenblatt's perceptron, ADALINE, MADLINE

Back Propagation Networks: Architecture of a Back propagation Network – the Perceptron Model, the solution, single layer Artificial Neural Network, Model for Multilayer Perceprton. **Back propagation Learning**: Input layer computation, Hidden layer computation, Output layer Computation, calculation of error, Training of Neural Network, Network – objective, supervise training, unsupervised training, Method of Steepest Descent , Effect of learning Rate , adding a momentum term, Applications

UNIT III

Fundamentals of Genetic Algorithms: History , Biological Background, Creation of Offsprings Working Principle, Encoding – Binary encoding, Octal Encoding, Hexadecimal Encoding, Permutation Encoding, Value Encoding, Tree encoding, Fitness function, Reproduction – Roulette wheel Selection, Boltzman selection Tournament Selection, Rank Selection, Steady state selection Differences and similarities between conventional and evolutionary algorithms,

Genetic Modeling: Inheritance Operators, Cross over-Single site, two point, Multi point, Uniform, Matrix Crossover, Cross over rate. **Inversion and Deletion**-Inversion, deletion and Duplication, Deletion and Regression, Segregation and Cross over and Inversion. **Mutation Operator** - Mutation, Mutation Rate

Genetic Programming (GP): The Primitives of Genetic Programmes: The Terminal Set, The Function Set The Basic GP Algorithm- Generational GP Algorithm, Steady – state GP Algorithm, Differences between GA & GP.

UNIT IV

Fuzzy Set Theory: Fuzzy Versus Crisp, Crisp sets- operations on crisp sets, properties of crisp sets, Partition and covering. **Fuzzy sets**- Membership Function, Basic Fuzzy Set Operations, properties of Fuzzy sets. **Crisp Relations** – Cartesian product, Other Crisp Relations, Operations on Relations, **Fuzzy Relations** – Fuzzy Cartesian Product, Operations on Fuzzy Relations

Applications of Optimization in Design And Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs, general optimization model of a machining process, optimization of arc welding parameters.

Text Books:

1. Engineering Optimization – Singiresu S. Rao, New Age Publishers,3rd edition,2010 .
2. Neural Networks,Fuzzy Logic, and Genetic Algorithms –Synthesis and Applications –S.Rajasekaram G A VijayalakshmiPai PHI.

Reference Books :

1. Genetic Programming – An Introduction - Wolfgang Banzhaf, Peter Nordin Robert E
2. .Keller Frank D. Francone.
3. Optimization for Engineering Design: Algorithms and examples – Kalyanmoy Deb, PHIPublishers,2012.
4. Multi objective Optimization using Evolutionary Algorithms - Kalyanmoy Deb, PHIPublishers,2010
5. Introduction to Optimum Design- Jasbir S. Arora, McGraw Hill (International) Publishers1989.

Web Resources:

1. http://www.nptel.ac.in/courses/105108127/pdf/Module_1/M1L4slides.pdf
2. https://en.wikipedia.org/wiki/Artificial_neural_network
3. http://www.geneticprogramming.com/Tutorial/
4. https://archive.org/stream/

23MEAM2002: COMPUTER INTEGRATED MANUFACTURING

Course Category: Programme Core	Credits:3
Course Type: Theory	Lecture-Tutorial-Practice:3-0-0
Prerequisites: CAD, CNC machines, Science of measurement	Continuous Evaluation:40
	Semester End Evaluation:60
	Total Marks=100

Course Outcomes

Upon successful Completion of the course, the student will be able to:

CO1: Learn fundamental concepts of manufacturing, automation, CAD/CAM and CIM.
CO2: Develop the basic concepts of Group technology, Machine cell design and Robotics.
CO3: Learn the building blocks of FMS and automated material handling systems such as AGVS.
CO4: Develop various types of Automated Storage and Retrieval Systems, automated contact and non- contact inspection techniques.

Course Content

UNIT I

Introduction: Automation: Need, Types, Advantages and Disadvantages of Automation, Automation Strategies, Types of Production, Functions in manufacturing, Introduction to CAD, Applications of Computers in Design, Introduction to CAM, Manufacturing Planning and control, Fundamentals and components of computer Integrated Manufacturing.

UNIT II

Group Technology: Introduction, Part families, Parts classification and coding (OPITZ & MULTI CLASS), Production flow analysis, Machine cell design, Types of cell design, Benefits of Group Technology.

Robotics: Robot anatomy, Robot Configuration, Basic Robot motions, Types of drivers, End effectors.

UNIT III

Flexible Manufacturing Systems: What is FMS, FMS Workstations, Materials Handling and storage system, Computer Control System, Planning the FMS, Applications and benefits.**Automated Material Handling:** Introduction, Types of material handling equipment, automated guided vehicle system (AGVS), Applications, Vehicle guidance and routing, Traffic control and safety, System management.

UNIT IV

Automated Storage Systems (AS): Storage systems performance, Automated storage / Retrieval systems (AS / RS), Basic components of AS /RS, AS / RS controls, Special features, applications.

Automated Inspection & Testing: Automated inspection principles and methods, sensor technologies for automated inspection, coordinate measuring machines (CMM), construction, operation & programming, CMM benefits and trends. Introduction to machine vision & non-contact inspection methods.

Text Book:

1. Automation, Production Systems, and Computer Integrated Manufacturing–M.P.Groover Pearson New International Edition, 2013.

Reference Books:

1. CAD/CAM - MikellP.Groover, and Emory W.Zimmers.Jr. PHI Publishers,1984
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers,2008
3. CAD/CAM/CIM, Radhakrishnan and Subramanian, New Age Publishers

Web resources:

1. http://www.enotes.com/computer-integrated-manufacturing
2. http://www.britannica.com/EBchecked/topic/computerintegrated–manufacturing.
3. http://en.wikipedia.org/wiki/computer-integratedmanufacturing#overview.

23MEAM2003: INDUSTRY 4.0

Course Category: Programme Core | Credits:3
Course Type: Theory | Lecture-Tutorial-Practice:3-0-0
Prerequisites: Manufacturing process, CAM, CIM | Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes

At the End of the course the student will be able to:

CO1: Understand the basics of Industrial Revolution.

CO2: Understand the Concepts of Industrial IOT in various sectors.

CO3: Understand the basic concepts of Industry 4.0.

CO4: Understand the applications of Industrial IOT and business issues in Industry 4.0.

Course Content

UNIT I

The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - The Journey so far: Developments in USA, Europe, China and other countries - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

UNIT II

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics.

UNIT III

Fourth Revolution – Sustainability assessment of Manufacturing Industry – Lean Production system – Smart and connected business perspective – smart factories – cyber-physical systems – collaboration platform and PLM.

UNIT IV

Applications: Inventory Management and Quality Control – Plant security and safety – Facility management – oil, chemical and Pharmaceutical Industry – Milk processing and packaging industries.

Business issues: Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world

Text Books:

1. The Fourth Industrial Revolution‖ by Klaus Schwab, World Economic Forum
2. NOC: Introduction to Industry 4.0 and Industrial Internet of Things.

Reference Book:

1. Internet of Things: A Hands-On Approach‖ by Arsheep Bahga and Vijay Madisetti, University Press

Web resources:

1. https://www.i-scoop.eu/industry-4-0/
2. https://www.techtarget.com/searcherp/definition/Industry-40

23MEAM2014A: ROBOTICS AND AUTOMATION

Course Category: Programme Elective III — Credits:3
Course Type :Theory — Lecture-Tutorial-Practice:3-0-0
Prerequisites : Vector Algebra, Basic Electronics — Continuous Evaluation:40
Semester End Evaluation:60
Total Marks:100

Course Outcomes

At the end of the course the student will be able to:
CO1: Understand the role of robotics in manufacturing automation and integration issues.
CO2: Analyse manipulator composition, selection of microcontroller/PLCs.
CO3: Illustrate the dynamics and control of robotic manipulators.
CO4: Apply robot programming language methods with reference to work cells and automation.

Course Content

UNIT I

Automation and robotics, evolution, robotic applications in automated processing, assembly and inspection, automated guided vehicles, multiple robots and machine interference, considerations in work-cell design, interlocks, economic justification.

UNIT II

Robot Anatomy, Degree of freedom, Manipulator classification, performance specifications: resolution, precision and accuracy, End-effector types, selection/design considerations.
Programmable Logic controllers in factory automation, Comparison of Microcontroller and PLC structure, ladder programming, and programming issues related to automation. P, PI, PID controllers.

UNIT III

Orthogonal coordinate systems, Transformation matrices, Denavit - Hartenberg algorithm for forward kinematics, Inverse Kinematics and singularities, Manipulator Dynamics, Motion and Force control of manipulators.

UNIT IV

Programming languages: VAL, RAIL, AML, structure of the language, programming methods, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through programming.
Importance of Vision and Image processing in robotics, Role of AI in robotic systems. Case studies on Robotics and automated manufacturing.

Text Books:

1. M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, “Industrial Robotics - Technology, Programming and Applications”, Mc Graw-Hill Book and Company (1987).
2. J. Nagrath and R. K. Mittal, “Robotics and Control”, TMH publishing Company Ltd., 2003 edition.

Reference Books:

1. John J. Craig, “Introduction to Robotics: Mechanics and Control”, Addison-Wesley Publishing Company, 3rd Edition, 2003.
2. M. Spong, M. Vidyasagar, S. Hutchinson, “Robot Modeling and Control”, Wiley & Sons, 2005.

3. Pires, “Industrial Robot Programming–Building Application for the Factories of the Future”, Springer (2007).
4. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, “ROBOTICS: Control, Sensing, Vision and Intelligence”, McGraw-Hill (1987).
5. Francis X Govers, “Artificial Intelligence for Robotics”,1st edition (Kindle edition), Packt Publishing Limited (2018).

Web Resources:

1. https://www.edx.org/course/robotics-dynamics-control-pennx-robo3x
2. https://www.coursera.org/learn/motion-and-kinetics
3. https://www.edx.org/course/robotics-vision-intelligence-machine-pennx-robo2x
4. https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/
5. https://see.stanford.edu/Course/CS223A

23MEAM2014B: COMPUTER AIDED INSPECTION AND TESTING

Course Category: Programme Elective III — Credits:3
Course Type: Theory — Lecture-Tutorial-Practice: 3-0-0
Prerequisites:Computer integrated manufacturing, Engineering Graphics, Matrices, Geometry — Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes

At the end of the course the student will be able to:

CO1: Understand fundamentals of the CAT, CAI, CAQC, inspection techniques automatic Inspection machines devices.
CO2: Learn the basics and applications of Coordinate Measuring Machines
CO3: Acquire knowledge of Machine Vision and various Scanning Laser Beam Devices
CO4: Understand the Machine Tool Sensing and Proximity Sensing

Course Content

UNIT I

Introduction: Computer aided testing (CAT) and computer aided inspection (CAI), computer aided quality control (CAQC), Fundamentals Of Inspection , Types of Inspection , Inspection Procedure, Inspection Accuracy, Inspection vs. Testing, on-line inspection and quality control, technology of automation Gauging, automatic inspection machines, in-process gauging

UNIT II

Coordinate Measuring Machines: Basic Types of Measuring Machines, CMM in Computer Aided Manufacturing, Advantages of CMM, probe types, operating modes, programming software's, accessories, measurement and inspection capabilities, flexible inspection systems, inspection problems.

UNIT III

Machine Vision: Functions of machine vision system, evaluating the performance of machine vision system, machine vision applications.
Scanning Laser Beam Devices: Laser interferometer, laser, alignment devices, X-ray optics, CCD (Charge-coupled Devices) Array, ultrasonic system.

UNIT IV

Machine Tool Sensing: Part measurement, Tool wear, Axial, motion, Sequence of functions, tool Identification. Computer aided surface roughness measuring systems, High accuracy profile measuring systems.
Proximity Sensing: Photoelectric Transducers, Image processing for vision sensor, 3 dimensional object recognition.

Text Books:

1. Machine Vision-Nello Zueh and Richard K.Miller prentice hall.
2. Roborts Sensor -Pugh, IFS Publication.
3. Transducers and Interfacing -Bannister and Whitehead~ Von Nostrand.
4. Computer Control of Manufacturing Systems -Koren, McGraw Hill

Reference Books:

1. John A Bosch., "Co-ordinate Measuring Machines and Systems", Marcel Dekker, Inc.1995
2. Fu S., Gonzalez R.C., Lee C.S.G., Robotics: Control, Sensing, Vision, and Intelligence. Tata MGH, New Delhi 1987

Web resources:

1. https://www.studocu.com/in/document/ranchi-university/computer-graphic/unit-1/25281712
2. https://learnmech.com/computer-aided-inspection-cim-notes/
3. 3.https://mrcet.com/downloads/digital_notes/me/iii%20year/computer%20aided%20design%20computer%20aided%20manufacturing.pdf

23MEAM2014C: COMPUTER GRAPHICS

Course Category: Programme Elective III — Credits:3
Course Type: Theory — Lecture-Tutorial-Practice:3-0-0
Prerequisites:Engineering Graphics, Matrices, Geometry — Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes
At the end of the course the student will be able to:

CO1: Understand fundamentals of the computer graphics devices.
CO2: Analyze the mathematical methods for Line generation in computer graphics.
CO3: Develop various Polygons and Illumination models and surface rendering related to Computer Graphics.
CO4: Apply the concepts of animation, windowing and clipping operation in computer graphics

Course Content

UNIT I

Introduction: Role of Computer Graphics in CAD/CAM, configuration of graphic workstations, menu design and Graphical User Interfaces (GUI), customization and parametric programming.
Geometry and Line Generation: Introduction, Lines, Line segments, Perpendicular Lines, Distance between a point and a Line, Vectors, Pixels and Frame Buffers.

UNIT II

Graphic Primitives: Introduction, Display devices, Primitive Operations, The Display-File Interpreter, Normalized Device Coordinates, Display-File structures
Polygons: Introduction to Polygons, Polygon representation, Polygon Interfacing Algorithms, Filling Polygons, Filling with a pattern, Initializing, Anti-aliasing**.**Product data standards in Computer Graphics.

UNIT III

Illumination models and surface rendering: Basic illumination models, Half-toning and dithering techniques, Polygon Rendering, Color models
Windowing: Introduction, The Viewing Transformation, Viewing transformation implementation

UNIT IV

Clipping: Clipping, the Cohen-Sutherland Algorithm, Clipping of Polygons, Sutherland-Hodgman algorithm.
Computer animation: Design of animation sequence, general computer animation functions, raster animation, key frame systems, motion specifications

Text Books:

1. Computer graphics by Steven Harrington McGraw Hill Education (India) Private Limited. Second Edition, 2014
2. IbrahimZeid "CAD/CAM – Theory and Practice" – McGraw Hill, International Edition, 1998.
3. Computer Graphics by Chopra Rajiv, 4th Edition, S Chand publications,2010

Reference Books:

1. Procedural elements for Computer Graphics by Rogers, Tata McGraw Hill, 2005
2. Donald Hearn and M.Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. David.F.Rogers, J.Alan Adams, "Mathematical elements for computer graphics" (second edition), Tata McGraw Hill edition, 1990.
4. William,M.Newman, Robert,F.Sproull, "Principles of interactive computer graphics" (second edition), Tata mcgraw Hill edition, 1997.
5. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.

Web resources:

1. http://www.ricum.edu.rs/files/3_1/TUG/CAD.pdf
2. http:// nptel.ac.in/courses/106106090/
3. http:// www.youtube.com/watch?v=fwzYuhduME4

23MEAM2015A: MACHINE LEARNING

Course Category: Programme Elective IV | Credits:3
Course Type: Theory | Lecture-Tutorial-Practice:3-0-0
Prerequisites: mathematics | Continuous Evaluation:40
Semester End Evaluation:60
Total Marks:100

Course Outcomes:

Upon successful Completion of the course, the student will be able to:

CO1: Acquire knowledge about various machine learning strategies.
CO2: Understand various Dimensionality Reduction Techniques
CO3: Understand and apply concepts of ANN to various applications
CO4: Understand and apply the various concepts of clustering and reinforcement learning

Course Contents

UNIT I

Brief Introduction to Machine Learning Supervised Learning Unsupervised Learning Reinforcement Learning Probability Basics Linear Algebra Statistical Decision Theory – Regression & Classification Bias – Variance Linear Regression Multivariate Regression

UNIT II

Dimensionality Reduction: Subset Selection, Shrinkage Methods, Principle Components Regression Linear Classification, Logistic Regression, Linear Discriminant Analysis Optimization, Classification-Separating Hyper planes Classification, dimensionality reduction for n variable optimization problem

UNIT III

Artificial Neural Networks (Early models, Back Propagation, Initialization, Training & Validation) Parameter Estimation (Maximum Likelihood Estimation, Bayesian Parameter Estimation) Decision Trees Evaluation Measures, Hypothesis Testing Ensemble Methods, Graphical Models.

Architecture of CNN and RNN and applications (prediction of optimized manufacturing process parameters, Signal and image processing, Natural Language processing, Face detection, recommender systems, Speech recognition)

UNIT IV

Clustering, Gaussian Mixture Models, Spectral Clustering Ensemble Methods Learning Theory, Reinforcement Learning- Active and passive Reinforcement Learning, Generalization in reinforcement learning, Applications (Robot control, cart-pole balancing problem)

Text Books:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.

2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

Reference Books:

1. TomMitchell,"MachineLearning",McGrawHill,3rdEdition,1997.
2. Charu C. Aggarwal, "Data Classification Algorithms andApplications", CRC Press, 2014.
3. Stephen Marsland,"Machine Learning–An Algorithmic Perspective",2nd Edition,CRC Press,2015.
4. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012
5. Jiawei Han and MichelineKambers and Jian Pei, "Data Mining –Concepts and Techniques", 3rdEdition,MorganKaufmanPublications,2012.

Web Resources:

1. https://www.geeksforgeeks.org/machine-learning/
2. https://www.infoworld.com/article/3214424/what-is-machine-learning-intelligence-derived-from-data.html

23MEAM2015B: CONDITION MONITORING AND FAULT DIAGNOSIS

Course Category: Programme Elective IV — Credits:3
Course Type :Theory — Lecture-Tutorial-Practice:3-0-0
Prerequisites :Mathematics, Mechanical vibrations — Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes
At the End of the course the student will be able to:

CO 1: Understand the maintenance scheme and their scope.
CO 2: Analyze signals for machine condition monitoring.
CO 3: Develop an appreciation for modern technological approach for condition Monitoring
CO 4: Illustrate various condition monitoring techniques.

Course Content

UNIT I

Maintenance – Introduction - objectives –types –concepts and economic benefits, Preventive maintenance –time based & condition based, Condition Monitoring & Performance monitoring, **Vibration Monitoring** –causes and effects of vibration. Review of Fundamentals of Vibrations, Vibration Measuring Equipment - Sensors, Signal conditioners, recording elements, Sensors – Factors affecting the choice of sensors, Contact type sensors –Non contact type sensors.

UNIT II

Signal Conditioning –Display/Recording elements, Vibration meters and analyser, Overall Level Measurement, Vibration limits & Standards, Signal Analysis -Frequency Analysis, Measurement of overall vibrations levels.

UNIT III

Special Vibration Measuring Techniques- Shock Pulse Method, Critical speed analysis, Orbit, vibration control, Wear behavior monitoring and Contaminants Monitoring Technique, Filters, chip detectors, Ferrography, Oil Analysis –oil degradation analysis, Abrasive Particle in oil, counters, Particle classification and counter.

UNIT IV

Performance Trend Monitoring –Primary and secondary parameters, Performance trend analysis, Performance trend monitoring systems, Temperature Monitoring –Various techniques – thermometer, thermocouple, Thermography, infrared pyrometers etc., Corrosion Monitoring – different techniques, Selection of condition motoring techniques,
Non-Destructive Techniques –important features, Types of defects detected by NDT –Visual, Dye Penetration, X-ray, Magnetic Flux test etc., Application of NDT Techniques.

Text Book:
1. Rao, J S., Vibration Condition Monitoring, Narosa Publishing House.

Reference Books:

1. Collacot R.A.- Mechanical fault diagnosis and condition monitoring
2. R. Mohanty Machinery Condition Monitoring: Principles and Practices, CRC Press.

Web Resources:

1. *http://freevideo*lectures.com/Course/2684/Mechanical- Vibrations.
2. http://freevideolectures.com/Course/3137/Soil-Dynamics/12
3. http://freevideolectures.com/Course/2684/Mechanical- Vibrations/36
4. http://www.cosmolearning.com/courses/mechanical-vibrations- 537/video-lectures/
5. http://www.cosmolearning.com/video-lectures/vibration-testingequipments-signal-analysis-11570/

23MEAM2015C: VISION SYSTEM AND IMAGE PROCESSING

Course Category:	Programme Elective IV	Credits:3
Course Type:	Theory	Lecture-Tutorial-Practice:3-0-0
Prerequisites:	Engineering mathematics	Continuous Evaluation:40
		Semester end Evaluation: 60
		Total Marks:100

Course Outcomes

At the End of the course the student will be able to:
CO1: Understand the fundamentals of image acquisition and processing.
CO2: Analyze image enhancement and restoration techniques
CO3: Apply image compression and segmentation techniques.
CO4: Apply object recognition concepts.

Course Content

UNIT I

Machine vision, Vision sensors, Visual perception, Low level vision, introduction to stereopsis, Image sensing and acquisition, Image sampling and Quantization, Gray level to binary image conversion, basic relationship between pixels, Linear and Non-linear Operations

UNIT II

Image enhancement, spatial domain techniques, Histogram Processing; Spatial Filtering. Frequency domain operations, Fast Fourier transform (FFT), Hough transform, Image Restoration, Image smoothing and sharpening, homo-morphic filtering

UNIT III

Image Compression, Fidelity criteria, Source encoder and decoder, Error free and Lossy compression Image segmentation, Edge detection, detection of discontinuities, region based segmentation, Region Growing

UNIT IV

Thresholding, Spatial smoothing, Boundary and Region representation, Shape features, Scene matching and detection, Image classification.

Text Books:

1. R C Gonzalez and R E Woods, “Digital Image Processing”, Pearson Education, 3rd edition, 2007.
2. Kenneth R Castleman “Digital Image Processing, Prentice Hall Press, 1996.

Reference Books:

1. S Jayaraman, T Veerakumar and S Esakkirajan, “Digital Image Processing”, Academic Press, 2009
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall, 1989
3. Chanda & Mazumdar “Digital Image Processing & Analysis”, PHI, 2011
4. R C Gonzalez, R E Woods, Steven L Eddins, “Digital Image Processing using MATLAB”, 2nd Edition, 2009 5.

5. Justin Solomon, “Numerical Algorithms: Methods for Computer Vision, Machine Learning and Graphics”, CRC Press, 2015

Web Resaources:

1. https://nptel.ac.in/courses/117105079
2. https://www.coursera.org/learn/image-processing

23MTAC2036: TECHNICAL REPORT WRITING

Course Category: Audit Course | Credits: 0
Course Type: Theory | Lecture-Tutorial-Practice: 2-0-0
Prerequisites: | Continuous Evaluation: 40
Semester End Evaluation: 60
Total Marks: 100

Course Outcomes:

At the End of the course the student will be able to:

CO1: Understand the significance of Technical Report writing.
CO2: Develop Proficiency in writing technical reports.
CO3: Apply the basic principles to prepare documentation using LATEX.
CO4: Understanding the need of Bibliography and references for quality report writing

23MEAM2051: CAM LABORATORY

Course Category: Programme Core | Credits:1.5
Course Type: Laboratory | Lecture-Tutorial-Practice: 0-0-3
Prerequisites: Machining processes, Modeling, Part programming | Continuous Evaluation: 40
Semester End Evaluation: 60
Total Marks: 100

Course Outcomes:

Upon successful Completion of the course, the student will be able to:

CO1: Understand and prepare Part Programs for different Turning operations.
CO2: Understand and prepare Part Programs for different Milling operations.
CO3: Prepare parts using the principle of 3D printing.
CO4: Prepare fasteners, sectional model and assembly of different components.

Course Content:

Part Programming and Machining

- Step Turning
- Taper & Profile Turning
- Multiple Turning, Threading, finishing and parting
- Linear & Circular interpolation
- Mirror Imaging
- Circular Pocketing
- Drilling

Additive Manufacturing

- Making a Feed Screw
- Making a Gear Wheel
- Muff Coupling
- Robotic hand gripper

Text Books:

1. CAD/CAM - PN Rao, PHI, 2004

Reference Books:

1. Computer Control of Manufacturing Systems – Y Koren, McGraw Hill, 1983 Web

Web resources:

1. http://www.mfg.mtu.edu/cyberman/machtool/auto/nc/index.ht ml

2. http://www.instruction.greenriver.edu/manufacturing/08Spr/N C%20PGM.pdf
3. http://elabz.com/wpcontent/uploads/2010/04/ER4u_User_Manual.pdf
4. http://cncmanual.com/?s=mastercam+manual
5. http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/
6. Computer%20Aided%20Design%20&%20ManufacturingII/Module%20F/Module%20F(1)/p1.htm
7. http://www.mfg.mtu.edu/cyberman/machtool/auto/nc/method .html

23MEAM2052: ROBOTICS LABORATORY

Course Category: Programme Core
Course Type: Laboratory
Prerequisites: Kinematics of machinery, Basic Electronics

Credits:1.5
Lecture-Tutorial-Practice: 0-0-3
Continuous Evaluation: 40
Semester End Evaluation: 60
Total Marks: 100

Course Outcomes

Upon successful completion of the course, a student will be able to:
CO1: Create and Simulate Robotic work cell using Modeling & Simulation software
CO2: Apply Material Handling Robot to perform Pick and Place Operation
CO3: Apply Arc Welding Robot to perform Seam Welding task.
CO4: Apply Spot Welding Robot to join parts through Spot Weld Joint.

Course Content

1. Introduction to Robotic Modelling and Simulation software for learning Offline Programming.
2. Create a work cell environment for a material handling robot to perform Pick and Place Job.
3. Learn the use of a Teach Pendant for Online Programming of a Robotic Manipulator
4. Create a program and execute Pick and Place Operation using Material Handling Robot
5. Create a program and produce a Seam Weld Joint using Arc Welding Robot.
6. Create a program and produce a Spot Weld Joint using Spot Welding Robot.
7. Testing of welds

Text Books:

1. Industrial Robotics by Mikell P. Groover, H Weiss, Roger N Nagel, Nicholas G Odrey, Ashish Dutta, Mc Graw Hill Education.
2. Robotic Engineering by Richard D. Klafter, Prentice Hall, Tata Mc Graw-Hill, 1995. 3rd Edition.
3. Robotics and Control - R K Mittal and I J Nagrath, THH Publications

Reference books:

1. Introduction to Robotics – John J. Craig, Addison Wesley,3rd Edition
2. Robotics – K. S. Fu, Gonzalez & Lee, Tata Mc Graw-Hill, 1995. 3rd Edition.

Web Resources:

1. https://library.abb.coH/
2. https://www.fronius.coH/en-in/india/
3. http://www.obara.co.jp/en/product/spot/controller.htHl

23MEAM2063: CAPSTONE PROJECT 2

Course Category: Capstone project
Course Type: Project
Prerequisites:

Credits:1
Lecture-Tutorial-Practice: 0-0-2
Continuous Evaluation: 40
Semester End Evaluation: 60
Total Marks: 100

Course Outcomes

Upon successful Completion of the course, the student will be able to:

CO1: Identify relevant experiences to academic knowledge from different courses

CO2: Make use of connections across disciplines, perspectives, fields of study;

CO3: Adopt and apply information to new situations;

CO4: Compile in meaningful self-reflection.

23MEAM2064: TERM PAPER

Course Category: Term Paper
Course Type: Term Paper
Prerequisites:

Credits:1
Lecture-Tutorial-Practice: 2-0-0
Continuous Evaluation: 40
Semester End Evaluation: 60
Total Marks: 100

Course Outcomes:

At the End of the course the student will be able to

CO1: Identify simple theoretical and practical problems related to the area of Automation.
CO2: Analyse / Solve theoretical / practical problems for arriving at feasible solutions.
CO3: Prepare an organized report employing elements of technical writing and critical thinking.
CO4: Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

23MEAM3011: MOOCS

Course Category: Programme Elective V
Course Type: MOOCS – Self Learning
Prerequisites:

Credits:3
Lecture-Tutorial-Practice: 3-0-0
Continuous Evaluation: 25
Semester End Evaluation: 75
Total Marks: 100

The following courses are offered under MOOCS platform:

1. Product Design and Manufacturing
2. Introduction To Mechanical Micro Machining
3. Mathematical Modeling of Manufacturing Processes
4. Automation in Manufacturing

23MEAM3061: PROJECT-PART A

Course Category: Project
Course Type: Project
Prerequisites:

Credits:10
Lecture-Tutorial-Practice:0-0-20
Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes:

At the End of the course the student will be able to

CO1: Identify a topic in relevant areas of Automated Manufacturing Systems.
CO2: Review the literature to identify gaps and define objectives & scope of the work.
CO3: Understand the methods and processes from literature and apply appropriate research methodologies.
CO4: Develop a model / experimental set-up / computational techniques and prepare a report and develop competence in presenting.

23MEAM3052: INTERNSHIP

Course Category: Internship — Credits:2
Course Type: Summer Training — Lecture-Tutorial-Practice:0-0-0
Prerequisites: — Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

The students shall undergo Internship/Summer training for a period of six weeks in Industry/Research organizations/ institute of higher learning approved by the Head of the Department during any time after the second semester and shall earn a minimum of two credits.

Course Outcomes:
At the End of the course the student will be able to

CO1: Develop communication, interpersonal and other critical skills in the job
CO2: Integrate theory and practice.
CO3: Build a record of work experience.
CO4: Explore career alternatives prior to graduation

23MEAM4061: PROJECT-PART B

Course Category: Project — Credits:16
Course Type: Project — Lecture-Tutorial-Practice:0-0-32
Prerequisites: — Continuous Evaluation:40
Semester end Evaluation:60
Total Marks:100

Course Outcomes:

At the End of the course the student will be able to

CO1: Identify methods and resources to carry out analysis and experiments.
CO2: Reorganize the procedures with a concern for society, environment and ethics.
CO3: Analyze and discuss the results to draw valid conclusions.
CO4: Prepare a report and defend the work and explore the possibility of publishing the work.