IPS Academy, Institute of Engineering & Science

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Mechanical Engineering Department

M.Tech (ROBOTICS) II Sem

S. No.	Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
			Theory			Practical						
			End Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem	Term work / Lab Work & Sessional		L	T	P	
1.	PSCC-MT201	Kinematics & Dynamics of Robot	70	20	10	-	-	100	3	1	0	4
2.	PSCC-MT202	Artificial Intelligence for Robots	70	20	10	-	-	100	3	1	0	4
3.	PSEC-MT201	Program Specific Elective-II	70	20	10	-	-	100	3	0	0	3
4.	OEC-MT201	Open Elective-I	70	20	10	-	-	100	3	0	0	3
5.	LC-MT201	Robot Program	-	-	-	60	40	100	0	0	4	2
6.	LC-MT202	Mechanism Synthesis Lab	-	-	-	60	40	100	0	0	4	2
7.	MLC - 2	Research Methodology & IPR	70	20	10	-	-	100	2	0	0	2
8.	AUD - 2	Audit Course -II	-	-	-	-	-	-	2	0	0	0
Total			**420**	**120**	**60**	**120**	**80**	**700**	**16**	**2**	**8**	**20**

*MST: Minimum of two mid semester tests to be conducted. L: LectureT: Tutorial P: Practical

S. No.	Program Specific Elective-II	Open Elective-I
1	PSEC-MT201(A) Pneumatic & Hydraulic Control	OEC-MT201(A) Simulation Modeling And Analysis
2	PSEC-MT201 (B) Instrumentation & Sensors	OEC-MT201(B) Image Processing
3	PSEC-MT201 (C) Flexible Manufacturing Systems (FMS)	OEC-MT201(C)Additive Manufacturing

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PSCC-MT201	Kinematics & Dynamics of Robot	3L : 1T : 0P (04 hrs)	Credits:04

Pre-requisite's: Kinematics and Dynamics of Machines

Course Objective:
- Impart knowledge and experiences of robot design and analysis, to students.
- This course integrates the knowledge on control systems, kinematics and dynamics which students have studied in their undergraduate level to be applied for robot design, control and analysis.

Course Content:

Module 1 **(08 hrs)**

Introduction: Introduction, position and orientation of objects, objects coordinate frame Rotation matrix, Euler angles Roll, pitch and yaw angles coordinate Transformations, Joint variables and position of end effectors, Dot and cross products, coordinate frames, Rotations, Homogeneous coordinates.

Module 2 **(10 hrs)**

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

Module 3 **(10 hrs)**

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

Module 4 **(12 hrs)**

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

Module 5 **(10 hrs)**

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

Course Outcome:

After completion of this course, the students are able to:
1. Kinematic analysis of the robot.
2. Analyze a given robot design in terms of kinematics and dynamics.
3. Use of inverse kinematics in robots.
4. Design and develop a robot to accomplish a specified task.
5. Study and analyse manipulator dynamics.

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List of Text Book:

1. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Phi Learning., 2009.
3. P.A. Janaki Raman, Robotics and Image Processing An Introduction, Tata Me Graw Hill Publishing company Ltd., 1995.
4. Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.

List of Reference Book:

1. Bernard Hodges, Industrial Robotics, Second Edition, Jaico Publishing house, 1993.
2. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, MIT Press., 2003.
3. John J. Craig, Introduction to Robotics Mechanics and Control, Third Edition, Pearson, 2008.
4. Bijay K. Ghosh, Ning Xi, T.J. Tam, Control in Robtics and Automation Sensor - Based integration, Academic Press, 1999.

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PSEC-MT202	Artificial Intelligence for Robots	3L:1T:0P (03 hrs)	Credits:04

Course Objective:

- To understand the concept of Artificial Intelligence (AI)
- To learn various peculiar search strategies for AI
- To acquaint with the fundamentals of mobile robotics
- To develop a mind to solve real world problems unconventionally with optimality

Course Content:

Module1: **(08 Hrs)**

Introduction: Introduction to artificial intelligence and intelligent agents, categorization of AI Problem solving: Production systems and rules for some AI problems: water jug problem, missionaries-cannibals problem etc. Solving problems by searching : state space formulation, depth first and breadth first search, iterative deepening.

Module2: **(06 Hrs)**

Intelligent search methods: A* and its memory restricted variants Heuristic search: Hill climbing, best-first search, problem reduction, constraint satisfaction. Game Playing: Minimax, alpha-beta pruning.

Module 3: **(06 Hrs)**

Knowledge and reasoning: Propositional and first order logic, semantic networks, building a knowledge base, inference in first order logic, logical reasoning systems.

Module 4: **(06 Hrs)**

Planning: Components of a planning system, goal stack planning, non-linear planning strategies, probabilistic reasoning systems, Baysian networks.
Learning: Overview of different forms of learning, Inductive learning, learning decision trees,

Module 5: **(08 Hrs)**

Computational learning theory, Artificial neural networks. Evolutionary computation: Genetic algorithms, swarm intelligence, particle swarm optimization. Applications: Robotics, Natural language processing.

Course Outcome:

1. Design smart system using different informed search / uninformed search or heuristic approaches
2. Solve problem using problem decomposition and planning
3. Identify knowledge associated and represent it by ontological engineering to plan a strategy to solve given problem.
4. Apply the suitable algorithms to solve AI problems
5. Describe robotics in practice

Text Books:

1. Rich and Knight, "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2014.
2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, 2011.

Reference Books:

1. Deepak Khemani, "A First Course in Artificial Intelligence", Tata McGraw Hill, 2013.
2. S. Russel and P.Norvig,"AI: A modern approach", 3rd Edition, Pearson Education, 2009.

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PSEC-MT201 (A)	Pneumatic & Hydraulic Control	3L:0T:0P (03 hrs)	Credits:03

Pre-requisite's: Fluid Mechanics and Hydraulic Machines

Course Objective:
To learn about pneumatic and hydraulic controls used in robotic system.

Course Content:

Module 1 **(08 hrs)**

Introduction Fluid Properties: Concepts of fluid dynamics, Hydraulic systems and their components, Pneumatic systems and their components, Use of fluid power, Properties of Hydraulic fluids, fluid flow fundamentals, Comparison of hydraulic and pneumatic systems, Safety considerations.

Module 2 **(10 hrs)**

Hydraulic System Hydraulic Power Transmission: Fluid power system design, Hydrostatic pumps and motors- Introduction, selection of pumps and motors, Types of motors and pumps, Some general considerations, comparison of motor performance characteristics. Hydraulic actuators and motors- Introduction, linear actuators, principal features, Actuator selection. Flow control valves- Valve configurations, symbolic representation, Valve analysis, three way spool valve analysis, flapper valve analysis, single and two stage pressure control valves, introduction to electro-hydraulic valves.

Module3 **(10 hrs)**

Pneumatic System & Pneumatic Fundamentals: Symbols, Pneumatic elements, Steady flow of ideal gases, orifice and nozzle calculations, capillary flow, flow of real gases, linear flow equations in orifices and nozzles. Multiple restrictions and volume calculations, Single acting pneumatic actuators and their applications.

Module4 **(10 hrs)**

Hydraulic and Pneumatic Control Elements: Control of single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, Counter valve application, Hydraulic cylinder sequencing control, speed control of hydraulic cylinder.

Module 5 **(10 hrs)**

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, memory valves. Flow control valves and speed control of cylinders- supply air throttling and exhaust air throttling, use of quick exhaust valve.

Course Outcomes:
After the successful completion of the course, the students will be able to:

1. Evaluate the performance of pumps and motors by determining the volumetric, mechanical, and overall efficiencies.
2. Explain the operation of gear, vane, and piston pumps, various types of control valves.
3. Identify and improve the safety considerations for working with the hydraulic system.
4. Identify and improve the safety considerations for working with the pneumatic system.
5. Design hydraulics and pneumatics circuits for various applications.

List of Text Book:

1. Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley & Sons.
2. B.W. Anderson, “The Analysis and Design of Pneumatic Systems”, Wiley.

List of Reference Book:

1. A.B. Goodwin, “Fluid Power Systems”, Macmillan.
2. Anthony Esposito, “Fluid power with applications”, Prentice Hall, 7th Edition.
3. Arthur Akers, Max Gassman, Richard Smith, “Hydraulic Power System Analysis”, Taylor and Francis Group.
4. Andrew Parr, "Pneumatic & Hydraulic", PHI.
5. John Pippenger & Tyler Hicks, “Industrial Hydraulics”, 3rd edition McGraw Hill.

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PSEC-MT201(B)	Instrumentation & Sensors	3L:0T:0P (03 hrs)	Credits:03

Course Objective:
To introduce to the students the operation of various electronic Instruments which are used to measure the electronic parameters.

Module 1: **(08 Hrs)**
Measurement and Characteristics: Elements of a Measurement System; Classification of Instruments; Static Performance Parameters; Loading and Impedance Matching; Errors and Uncertainties in Measurement; Process and Standards of Calibration; Dynamic Characteristics-Transfer Function Representation of a Measurement System, Impulse and Step Responses of First and Second Order Systems, Frequency Response of First and Second Order Systems.

Module2: **(08 Hrs)**
Error Analysis: Types of errors, Methods of error analysis, uncertainty analysis, statistical analysis, Gaussian error distribution, chi- square test, correlation coefficient , students T – test , method of least square , curve fitting, graphical analysis. Electrical Measurement: DC measurements, DC voltmeter, Ammeter ohmmeter, digital type voltmeter, Ammeter ohmmeter, AC measurement, Ammeter, ohmmeter, AC voltmeter using rectifier, true RMS voltmeter, Digital VOM meter.

Module3: **(08 Hrs)**
Transducers: Principles and classification of transducers, guidelines for selection and application of transducers, basic requirements of transducers. Different types of transducers. Display Devices and Recorders: Telemetry & Remote sensing, GIS (Geographical information System), various display devices and Recorder, CRO (basic block diagram, deflection sensitivity, application: voltage, current, frequency and phase angle measurement). Digital R-L-C meters, digital frequency Meter and Universal Counter.

Module 4: **(08 Hrs)**
Sensors: Classification, characteristics and calibration of different sensors, position sensors, motion sensors, force sensors, torque sensors, strain gauge sensors, pressure flow sensors, temperature sensors, smart sensors, tactile and proximity sensors, opto-electrical sensor, Principles and structures of modern micro sensors.

Course Outcome:
1. Understand operation of different instruments.
2. Describe different terminology related to measurements.
3. Understand the principles of various types of transducers and sensors.

List of Text Books :

1. "Transducers and Instrumentation", D.V.S. Murthy, PHI 2003.
2. "Modern Electronic Instrumentation and Measurement Techniques" Albert D Helfrick and William D Cooper, PHI. 2004.
3. "Instrumentation, Measurement and Analysis", Nakra and Chaudhry, Tata McGraw-Hill.

List of Reference Books:

1. C.S. Rangan, G.R. Sarma, and V.S.V. Mani, "Instrumentation Devices and Systems", Tata McGrawHill.
2. S.K. Singh, "Industrial Instrumentation and Control" Tata Mcgrow-Hill (Third Edition).
3. K. Krishnaswamy and S. Vijaychitra, "Industrial Instrumentation", New Age International Publishers, Second Edition.
4. Doeblin and Ernest, "Measurement Systems Application and Design", Tata McGraw-Hill 2004.
5. D. P. Eckman, "Industrial Instrumentation", CBS Publishers and Distributer.

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PSEC-MT201(C)	Flexible Manufacturing Systems (FMS)	3L:0T:0P (03 hrs)	Credits:03

Pre-requisite's: Manufacturing Processes and Technologies

Course Objective:
Understand the role of Flexible Manufacturing Systems (FMS) in manufacturing, concept of Group Technology, Cellular Mfg Systems, benefits of automation, Be familiar with organization and information processing in manufacturing, Have a basic knowledge of automation equipment, Understand logic control and associated technologies.

Course Content:

Module 1 **(10 hrs)**

FMS Introduction: Definition of an FMS-need for FMS, types and configuration, types of flexibilities and performance measures. Economic justification of FMS. Development and implementation of FMS- planning phases, integration, system configuration, FMS layouts, simulation.

Module 2 **(10 hrs)**

Automated Material Handling And Storage: Functions – types - analysis of material handling systems, primary and secondary material handling systems-conveyors, Automated Guided Vehicles-working principle, types, traffic control of AGVs. Role of robots in material handling. Automated storage systems- storage system performance – AS/RS-carousel storage system, WIP storage systems, interfacing handling and storage with manufacturing. 34 CIM-2013 SRM(E&T)

Module 3 **(10 hrs)**

Computer Control Of FMS: Planning, scheduling and computer control of FMS, Hierarchy of computer control, supervisory computer. DNC system- communication between DNC computer and machine control unit, features of DNC systems.

Module 4 **(10 hrs)**

Computer Software, Simulation And Data Base Of FMS: System issues, types of software – specification and selection- trends application of simulation and its software, Manufacturing Data systems planning FMS data base. Modeling of FMS- analytical, heuristics, queuing, simulation and petrinets modeling techniques.

Module 5 **(10 hrs)**

Scheduling of FMS: Scheduling of operations on a single machine- two machine flow shop scheduling, two machine job shop scheduling, - three machine flow shop scheduling- scheduling 'n' operations on 'n' machines, knowledge based scheduling, scheduling rules, tool management of FMS, material handling system schedule

Course Outcome:

1. Apply the concepts of PPC and GT to the development of FMS.
2. Discuss the planning and scheduling methods used in manufacturing systems.
3. Identify various workstations, system support equipments.
4. Identify hardware and software components of FMS.

5. Summarize the concepts of modern manufacturing such as JIT, supply chain management and lean manufacturing etc.

List of Text/Reference Book:

1. Jha. N.K., 'Hand Book of Flexible Manufacturing Systems', Academic Press Inc,1991
2. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 1995.
3. Parish.D.J., 'Flexible Manufacturing' ,Butter worth-Heinemann Ltd,1990.
4. Groover. M. P., 'Automation production systems and computer integrated manufacturing', Prentice hall of India pvt.Ltd, 1989.
5. Taiichi Ohno, "Toyota production system: beyond large-scale production" Productivity Press (India) Pvt. Ltd. 1992.
6. Buffa .E.S. and Sarin, 'Modern Production and Operations Management', Wiley Eastern, 1987.
7. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd.,New Age International Ltd., 1994.

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PSEC-MT201(A)	Simulation Modeling and Analysis	3L:0T:0P (03 hrs)	Credits:03

Course Objective:
Define the basics of simulation modeling and replicating the practical situations in organizations Generate random numbers and random variates using different techniques.

Module 1: **(08 Hrs)**
Introduction to Simulation: Simulation, advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study. Random Numbers: Properties, Generations methods, Tests for Random numbers – Frequency test, Runs test, Autocorrelation test, Gap test, Poker test.

Module 2: **(08 Hrs)**
Simulation Examples: Simulation of Queuing systems, Simulation of Inventory System, Monte Carlo simulation, General Principles, Concepts in discrete – events simulation, event scheduling /Time advance algorithm.

Module 3: **(08 Hrs)**
Introduction to Probability distributions: Weibull, Triangular, Erlang and Gamma distributions and their applications (No analytical treatment) Random Variate Generation: Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and lognormal Distributions Convolution Method – Erlang distribution Acceptance and Rejection technique – Poisson and Gamma distributions

Module 4: **(08 Hrs)**
Input Modeling: List of steps involved in input modeling – no analytical treatment Selecting input models without data, Multivariate and time series input models – Covariance and correlation, multivariate input models, time series input models Verification and Validation of Simulation Model: Model Building, Verification and validation, Verification of simulation models, Calibration and Validation of Models, Naylor and Finger's validation process.

Module 5: **(08 Hrs)**
Output analysis for a single model: types of simulations, stochastic nature of output data, Output analysis of terminating simulations, Output analysis of steady state simulations Optimization via simulation: What does "optimization via simulation" mean? Why is optimization so difficult? Basic GA and TS.

Course Outcome:
After the successful completion of the course, the students will be able to:
1. Describe the role of important elements of discrete event simulation and modeling paradigm.
2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
3. Develop skills to apply simulation software to construct and execute goal-driven system models.
4. Interpret the model and apply the results to resolve critical issues in a real world environment.

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List of Text Books :

1. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol -Discrete Event system Simulation, III Edition, Pearson Education, Asia, ISBN – 81- 7808 – 505 – 4.
2. Narsingh Deo -Systems Simulation with Digital Computer; PHI Publication (EEE), ISBN – 0-87692-028-8.

List of Reference Books:

1. Averill M Law, W David Kelton -Simulation Modeling & Analysis, McGraw Hill International Editions – Industrial Engineering series, ISBN – 0-07-100803-9.

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OEC-MT201 (B)	Image Processing	3L:0T:0P (3 hrs)	Credits:03

Course Objective:
To treat the 2D systems as an extension of 1D system design and discuss techniques specific to 2D systems.

Course Content:

Module1: **(08 Hrs)**
Introduction & Digital Image Fundamentals: 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.

Module2: **(08 Hrs)**
Image Enhancement in the Spatial Domain: Some basic Gray Level Transformations, Histogram Equalization, Enhancement Using Arithmetic and Logic operations, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Method, Image Negation. Image Enhancement in the Frequency Domain: Introduction to Fourier Transform and its properties, Fast Fourier Transform, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering.

Module 3: **(08 Hrs)**
Image Restoration: Model of the Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations. Image Compression: 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.

Module 4: **(08 Hrs)**
Image Segmentation: Detection of Discontinuities - point, lines and edge segmentation, Edge linking and boundary detection, Thresholding, Region Oriented Segmentation.
Representation and Description: Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description,
Morphological Image Processing: Erosion and dilation, Some basic Morphological Algorithms

Course Outcome:
1. Understand the need for image transforms different types of image transforms and their properties.
2. Develop any image processing application.
3. Understand the rapid advances in Machine vision.
4. Learn different techniques employed for the enhancement of images.
5. Learn different causes for image degradation and overview of image restoration techniques.
6. Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.

7. Learn different feature extraction techniques for image analysis and recognition.

Text Books:

1. Rafael C. Gonzalez & Richard E. Woods, “Digital Image Processing”, 3rd Edition, Pearson Education, 2009.

Reference Books:

1. A.K. Jain, “Fundamental of Digital Image Processing”, PHI, 2003.
2. William K. Pratt, “Digital Image Processing”, Wiley, 2007.
3. Milan Sonka, VaclavHlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" 3rd Edition, Cengage Learning, 2008.

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OEC-MT201 (C)	Additive Manufacturing	3L:0T:0P (3 hrs)	Credits:03

Pre-requisite's: Material Technology and Manufacturing Processes

Course Objective:
- To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques.
- To familiarize students with different processes in rapid prototyping systems.

Course Content:

Module 1 **(08 hrs)**

Introduction and Classification: Additive Manufacturing (AM) processes, AM evolution, Distinction between AM & Computer Numeric Control (CNC) machining, Advantages, Limitation and Future Scope of AM.

Module2 **(12 hrs)**

Classes of Materials for AM and its Processing Mechanisms: ABS plastic, PLA, Polyamide (nylon), Glass Filled Polyamide, Stereo lithography Materials (Epoxy Resins), Silver, Titanium, Steel, Wax, Photopolymers and Polycarbonate, Pure Metals Powder, Alloys Powder, Multi-Component Metals/Alloys Powder Mixture.

Module 3 **(10 hrs)**

General Physical Aspects and Design Strategies: for AM, Microstructural properties, Mechanical Properties and Performance, Structure, Property Stability of AM Processed Parts. Machines for Rapid Prototyping, Direct Tooling, and Direct Manufacturing.

Module 4 **(10 hrs)**

AM process consideration and control methods: Material Processing Issues, Feature Size, Surface Finish, and Geometry Scaling, Build Chamber Atmosphere, Feedstock Quality, Porosity, Scan Strategy, Deposition Strategy, Cracking, Delamination, & Swelling, Substrate Adherence & Warping, Residual Stress, Heat Transfer, Solidification, and Thermal Cycles, Modes of Heat Transfer, Solidification, Speed-Power Relationship.

Module 5 **(10 hrs)**

Application of AM: Biomedical implants, metal components, Aerospace, Automobile etc. and case studies.

Course Outcomes:

After the completion of this course, the student will be able to:
1. Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping technologies.
2. Describe different RP techniques.
3. Discuss fundamentals of Reverse Engineering.
4. Apply control methods to various AM processes.
5. Execute the AM processes for different cases.

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List of Text Book:

1. Ian Gibson, David W. Rosen, Brent Stucker , "Additive Manufacturing Technologies" , Springer,2009
2. Chua C. K., Leong K. F., and Lim C. S., "Rapid Prototyping: Principles and Applications", Second Edition, World Scientific Publishers (2003),.
3. Patri K. Venuvinod, Weiyin Ma "Rapid Prototyping: Laser-Based and Other Technologies" Springer, 2004.

List of Reference Book:

1. Peter D. Hilton, Hilton/Jacobs, Paul F. Jacobs, "Rapid Tooling: Technologies and Industrial Applications", CRC Press, 2000.
2. Burns. M, "Automated fabrication", Prentice-Hall, 1993.

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LC-MT201	Robot Program	0L:0T:4P (04 hrs)	Credits:02

Course Objective:

The course is designed to provide an introduction to the Python programming language. The focus of the course is to provide students with an introduction to programming, I/O, and visualization using the Python programming language.

List of Experiments:

1. Arithmetic Operations
2. Built-in Functions
3. Loops
4. Data Types
5. Strings
6. Classes and Objects
7. Built-in Modules
8. Constructors and Inheritance
9. File Operators
10. GUI Application

Course Outcome:

1. To acquire programming skills in core Python.
2. To acquire Object Oriented Skills in Python
3. To develop the skill of designing Graphical user Interfaces in Python
4. To develop the ability to write database applications in Python

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LC-MT202	Mechanism Synthesis Lab	0L:0T:4P (04 hrs)	Credits:02

Pre-requisite's: Theory of Machines

Course Objective:
- To develop a solution oriented approach by in depth knowledge of Theory of Machines.
- To address the underlying concepts, methods and application of different machines.

List of Experiment:
1. To Study and Analyse Four bar Mechanisms and their Inversions
2. To Study and Analyse Slider Crank Mechanism
3. To Study and Analyse Rotary Engine Mechanism
4. To Study and Analyse Crank and Slotted Lever Mechanism
5. To Study and Analyse Oscillating cylinder Mechanism
6. To Study and Analyse Bull engine Mechanism
7. To Study and Analyse Elliptical Trammel Mechanism
8. To Study Scotch-yoke Mechanism
9. To Study Robert's Straight Line Mechanism
10. To Study Chebyshev Straight Line Mechanism

Course Outcomes:
After completion of this course, the students are able to:
1. The student can identify different areas of Theory of Machines.
2. Can find the applications of all the areas in day to day life.

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MLC-2	Research Methodology & IPR	2L:0T:0P (02 hrs)	Credits:02

Pre-requisite's: Nil

Course Objective:
- Understand some basic concepts of research and its methodologies, identify appropriate research topics and select and define appropriate research problem and parameters

Course Content:

Module 1 **(08 hrs)**

Research Formulation and Design: L-9 Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, identifying gap areas from literature and research database.

Module 2 **(08 hrs)**

Data Collection And Analysis: Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

Module 3 **(10 hrs)**

Soft Computing: L-9 Computer and its role in research, Use of statistical software SPSS, GRETL etc. in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.

Module 4 **(10 hrs)**

Research Ethics, IPR And Scholarly Publishing: Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing-IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

Module 5 **(10 hrs)**

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

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Course Outcomes:

After completion of this course, the students are able to:

1. Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. Have basic knowledge on qualitative research techniques
3. Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis.
4. Understand the ethics used in research approach.
5. Apply the knowledge of research methodology for report writing.

List of Text Book:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Publications.

List of Reference Book:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.