Semester - I

SAVITRIBAI PHULE PUNE UNIVERSITY

Structure and Syllabus

FOR

M. E. Mechanical Engineering

(*Robotics & Automation*)

2021-Course

UNDER FACULTY OF ENGINEERING EFFECTIVE

FROM JULY 2021

Course Code	Course Name	Teaching Scheme (Hrs/week)		Examination Scheme and Marks						Credits
		TH	PR	IN SEM	END SEM	TW	PR	Oral	Total	
MERA501	Advanced Mathematics and Numerical Methods	4	0	50	50	-	-	-	100	4
MERA502	Machine Vision System	4	0	50	50	-	-	-	100	4
MERA503	Total Integrated Automation Industry 4.0	4	0	50	50	-	-	-	100	4
MERA504	Engineering Research Methodology	4	0	50	50	-	-	-	100	4
MERA505	Elective-I	5	0	50	50	-	-	-	100	5
MERA506	Lab Practice-I	-	4	-	-	50	-	50	100	4
Total:		**21**	**4**	**250**	**250**	**50**	**0**	**50**	**600**	**25**

Elective - I			
MERA505A	Sensors Application in Manufacturing	MERA505C	Mechatronics
MERA505B	Microcontrollers and Single Board Computers	MERA505D	CAD/CAM

Semester - II										
Course Code	**Course Name**	**Teaching Scheme (Hrs/week)**		**Examination Scheme and Marks**					**Total**	**Credits**
		TH	**PR**	**IN SEM**	**END SEM**	**TW**	**PR**	**Oral**		
MERA507	Artificial Intelligence and Machine learning for Robotics	4	0	50	50	-	-	-	100	4
MERA508	Digital signal & Video processing	4	0	50	50	-	-	-	100	4
MERA509	Robotic operating system	4	0	50	50	-	-	-	100	4
MERA510	Elective -II	5	0	50	50	-	-	-	100	5
MERA511	Seminar I		4	0	-	50	-	50	100	4
MERA512	Lab Practice-II	-	4	0	-	50	-	50	100	4
Total:		**17**	**8**	**200**	**200**	**100**	**0**	**100**	**600**	**25**

Elective - II			
MERA510A	Additive Manufacturing & Tooling	MERA510C	Kinematics & dynamics of Robots
MERA510B	Industrial Robotics & material handling system	MERA510D	Flexible Manufacturing Systems

Semester - III										
Course Code	**Course Name**	**Teaching Scheme (Hrs/week)**		**Examination Scheme and Marks**					**Total**	**Credits**
		TH	**PR**	**IN SEM**	**END SEM**	**TW**	**PR**	**Oral**		
MERA513	Robotics application	4	-	50	50	-	-	-	100	4
MERA514	Automatic control & Power System	4	-	50	50	-	-	-	100	4
MERA515	Elective III	5	-	50	50	-	-	-	100	5
MERA516	Mini Project with Seminar	-	4	-	-	50	-	50	100	4
MERA517	Dissertation Stage I	-	8	-	-	50	-	50	100	8
Total:		**13**	**12**	**150**	**150**	**100**		**100**	**500**	**25**

Elective III			
MERA515A	Internet of things	MERA515C	Cloud Computing
MERA515B	Block chain Technology	MERA515D	Data Science & Big Data system

Semester - IV									
Course Code	**Course Name**	**Teaching Scheme (Hrs/week)**	**Examination Scheme and Marks**						**Credits**
		TH / PR	**IN SEM**	**END SEM**	**TW**	**PR**	**Oral**	**Total**	
MERA518	Industry Internship / In house Research Project	5	-	-	50	-	50	100	5
MERA519	Dissertation Stage I	20	-	-	150	-	50	200	20
Total:		**25**			**200**		**100**	**300**	**25**

SEMESTER-I

MERA501: ADVANCED MATHEMATICSAND NUMERICAL METHODS				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Basic Mathematics			
Course Objectives:	To equip the students with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.			
Course Outcomes:	The students will be able to learn 1. To deal with derivative of functions of several variables that are essential in various branches of Engineering. 2. To use the essential tool of matrices and linear algebra in a comprehensive manner for analysis of system of linear equations, finding linear and orthogonal transformations, Eigen values and Eigen vectors applicable to engineering problems			

UNIT I- Linear Algebraic Equations: Gauss – Elimination, Gauss – Seidel, LU Decomposition, Solution of algebraic and transcendental equations: - Bisection Method, False position method, Newton – Raphson Method, Muller's method, Barstow's Method, Convergence and stability

UNIT II- Regression Analysis: i) Linear regression, multiple linear regressions, polynomial regression. ii) Nonlinear regressionGauss– Newton method, multiple nonlinear regressions. Interpolation: Newton's Divided Difference, Lagrange's Inverse, Spline, Hermite Interpolation, Extrapolation technique of Richardson's Gaunt

UNIT III - Differentiation & Integration: Divided difference formulae, Romberg integration, Gauss quadrature for double & triple integration.

UNIT IV- Eigen Values & Eigen Vectors of Matrices: Faddeev- Laeverrier's method, Power Method, Householder & Given's method.

UNIT V- Ordinary differential equations Euler's method, Heun's method, Mid – point method, Runge – Kutta methods, Multi step Methods - explicit Adams – Bashforth technique & Implicit Adams – Moulton Technique, Adaptive RK method, Embedded RK method, step size control. Higher order ODE – Shooting method. Nonlinear ODE – Collocation technique.

UNIT VI - Partial Differential Equations: Solution of Parabolic and Hyperbolic equations –Implicit & Explicit Schemes, ADI methods, Non-linear parabolic equations-Iteration method. Solution of elliptic equation – Jacobi method, Gauss – Seidel & SOR method. Richardson method

TEXT BOOKS:

1. Thomas G.B. and Finney R.L – Calculus and Analytic Geometry, Pearson Education, New Delhi, 2012.
2. Erwin K. –Advanced Engineering Mathematics, Wiley India Pvt. Ltd, New Delhi, 2012.
3. Rammana B.V. - Higher Engineering Mathematics Tata Mc-Graw-Hill 2012.

REFERENCE BOOKS:

1. Wylie C.R. and Barrett L.C. - Advanced Engineering Mathematics, Tata Mc-Graw-Hill, New Delhi, 2013.
2. Peter V.O'Neil - Advanced Engineering Mathematics, Cengage, New Delhi, 2010.
3. Gupta S.C. and Kapoor V.K. Fundamentals of Mathematical Statistics, S. Chand andSons.2002.

MERA502:MACHINE VISION SYSTEM				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	Sensors Technology, Robot Programming, Artificial Intelligence for Robotics.			
Course Objective	1. Be able to acquire and process raw image data. 2. Be able to relate image data to 3D scene structures. 3. Know the concepts behind and how to use several model-based object representations, and to critically compare them. 4. Know many of the most popularly used current computer vision techniques.			
Course Outcomes	1. Represent and interpret image in its numeric and graphical form. 2. Write simple codes for improving image quality. 3. Extract useful information from image contents through processing. 4. Understand and document needs for specific machine vision system. 5. Develop machine vision system based on requirement.			

Unit I: Introduction: Human vision, Machine vision and Computer vision, Benefits of machine vision. Image acquisition: Scene constraints, Lighting parameters, Lighting sources, Selection, Lighting Techniques, Types and Selection, Machine Vision Lenses and Optical Filters, Specifications and Selection, Imaging Sensors, CCD and CMOS, Specifications, Interface Architectures, Analog and Digital Cameras, Digital Camera Interfaces.

Unit II: Image processing: Machine Vision Software, Fundamentals of Digital Image, Image Acquisition Modes, Image Processing in Spatial and Frequency Domain, Point Operation, Thresholding, Grayscale Stretching, Neighborhood Operations, Image Smoothing and Sharpening, Edge Detection, Binary Morphology Color image processing.Image analysis: Feature extraction, Region Features, Shape and Size features, Texture Analysis, Template Matching and Classification.

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

Unit IV: Industrial M/C vision: Industrial machine vision in production and services, structure of industrial m/c vision, generic standards, rules of thumb, illumination, optics, image processing, interfacing machine vision system, vision system calibration

Unit V: Object Detection and Classification- Shape based object classification, motion based object classification, Silhouette-Based Method for Object Classification, Viola Jones object detection framework, Multiclass classifier boosting. Multi-Object Tracking- Classification of multiple interacting objects from video, Region-based Tracking, Contour-based Tracking, Feature-based Tracking, Model-based Tracking and Hybrid Tracking.

Unit VI: Human Activity Recognition- Template based activity recognition, Sequential recognition approaches using state models (Hidden Markov Models), Human Recognition Using Gait, HMM Framework for Gait Recognition, Description based approaches, Human interactions, group activities, Applications and challenges.

REFERENCES:

1. Trucco Emanuele, Verri Alessandro, “Introductory Techniques For 3D Computer Vision”, First Edition, 2009
2. Gonzales Rafael C., Woods Richard. E., “Digital Image Processing Publishers”, Third Edition, 2007
3. Hornberg Alexander, “Handbook of Machine Vision”, First Edition, 2006.
4. Eugene Hecht, Ganesan A. R. “Optics”, Fourth Edition, 2001.

MERA503: TOTAL INTEGRATED AUTOMATION AND INDUSTRY4.0				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	Sensor technology			
Course Objective	1. The aim of the course is to provide knowledge about the design of smart plants and knowledge of new technologies in digitalization and automation. 2. The course will also provide basic insight and understanding of the requirements need to adapt design rules for products to be manufactured in smart factories.			
Course Outcomes	1. Describe working of various blocks of basic industrial automation system. 2. Connect the peripherals with the PLC. 3. Use various PLC functions and develop small PLC programs. 4. Summarize Distributed control system and SCADA system. 5. Use various industrial motor drives for the Industrial Automation. 6. Demonstrate ability to understand and apply requirements on robots, smart machines and products to be integrated into an industry 4.0 automation solutions.			
UNIT- I Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, BreakEven Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.				
UNIT-II Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines				
UNIT-III Material handling and Identification Technologies: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc. Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.				
UNIT-IV Control Technologies in Automation: Industrial Control Systems, Process Industries Verses DiscreteManufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, SCADA System & RTU.				
UNIT-V Automated Inspection and Testing: Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical				

Inspection Methods

UNIT-VI

PLC: Introduction, Micro PLC, Programming a PLC, Logic Functions, Input & Output Modules, PLC Processors, PLC Instructions, Documenting a PLC System, Timer & Counter Instructions, Comparison & Data Handling Instructions, Sequencing Instructions, Mask Data Representation, Typical PLC Programming Exercises for Industrial Applications.

TEXT BOOKS:

1. Bailey David, Bright Edwin, ―Practical SCADA for industry, Newnes, Burlington, 2003.
2. Clarke Gordon, Reyneders Deon, Wright Edwin, ―Practical Modern SCADA Protocols: DNP3, 60870.5 and Related systems, Newnes Publishing, 2004.
3. "Automation, Production Systems and Computer Integrated Manufacturing"- M.P.Grover, Pearson Education.
4. "Computer Based Industrial Control" – Krishna Kant, EEE-PHI
5. Principles and Applications of PLC – Webb John, Mcmillan 1992
6. "An Introduction to Automated Process Planning Systems" – Tiess Chiu Chang & Richard A. Wysk
7. "Anatomy of Automation" – Amber G.H & P.S. Amber, PrenticeHall.

REFERENCES:

1. Shaw William T, ―Cybersecurity for SCADA systems, PennWell, 2006.
2. McCrady Stuart G, ―Designing SCADA Application Software, Elsevier, 2013.
3. SIMATIC STEP 7 in the Totally Integrated Automation Portal, SIEMENS AG, 2012.

MERA504:ENGINEERING RESEARCH METHODOLOGY				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	-			
Course Objective	1. To understand the philosophy of research in general 2. To understand basic concepts of research and its methodologies 3. To learn the methodology to conduct the Literature Survey 4. To acquaint with the tools, techniques, and processes of doing research 5. To learn the effective report writing skills and allied documentations 6. To become aware of the ethics in research, academic integrity and plagiarism			
Course Outcomes	On completion of the course, learner will be able to– 1. Identify appropriate topics for research work in computer engineering 2. Carry out Literature Survey 3. Select and define appropriate research problem and parameters 4. Design the use of major experimental methods for research 5. Use appropriate tools, techniques, and processes of doing research in Computer science 6. Become aware of the ethics in research, academic integrity and plagiarism 7. Write a research report and thesis			

Unit - I Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.
Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

Unit - II Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Literature Review: Need of Review, Guidelines for Review, Record of Research Review.

Unit - III Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

Unit - IV Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software

Unit - V Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

Unit - VI Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report

writing, making presentation, Use of visual aids. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

TEXT BOOKS:

1. Dieter G E, Engineering Design, McGraw, Hill, 2009.
2. Karl T, Ulrich and Steven D, and Eppinger, Product Design and Development, McGraw Hill 2009.
1. Cotterell Mike and Hughes Bob, "Software Project Management - Inclination", Tata McGraw Hill, 2001.

REFERENCES:

1. Wysocki Robert K, Robert Beck Jr and Crane David B., "Effective Project Management", John Wiley & Sons Inc., 1995.
2. Bennatain E M, "On Time, Within Budget", John Wiley & Sons Inc., 1995.
3. McConnell Steve, "Software Project Survival Guide", Microsoft Press, 1998.
4. Pressman R S, "Software Engineering - A Practitioner's Approach" McGraw Hill Book Company, 2001.
5. Hurst Ken, ―Engineering Design Principles, Elsevier Science and Technology Books, 2006.

MERA 505A: ELECTIVEI -SENSORS APPLICATIONS IN MANUFACTURING				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	5 Hrs/Week	5	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	Sensors Technology, Robot Programming, Artificial Intelligence for Robotics.			
Course Objective	1. Understand how sensor manufacturers characterize and calibrate their sensors. 2. Tune a PID control loop and access the PID control function of the Cypress PSoC development kit for a motor control application 3. Understand manufacturing methods used to build electro-mechanical an micro-machined sensors			
Course Outcome	1. Identify and understand the basics of sensors and their integration in different manufacturing systems 2. Discus and identify the sensors and their application 3. Comprehend and analyze various systems like RFID, color sensors, code sensors,etc. for understanding vehicle dynamics and stability. 4. Comprehend the various networking sensors for manufacturing, machining &tracking systems. 5. Identify various technologies developed for cryogenic and semiconductor applications. 6. Recognize various temperature detector and process sensor followed within the manufacturing system systems.			
Unit I: Fundamentals of Sensors and Transducers: Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter.				
Unit II: Sensors and their applications: Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors.				
Unit III: Advanced Sensor Technologies: Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electromagnetic identifier, optical encoders, color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor. fuzzy logic for optelectronic colour sensor in manufacturing. Sensors in Flexible Manufacturing Systems: Vision sensors, image transformations, robotvisual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing				
Unit IV: Networking: Networking of sensors, control of manufacturing process, tracking- the meantime between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.				
Unit V: Sensors for Special Applications: A multi objective approach for selection of sensors in manufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using				

Unit VI:
Photoluminescence temperature detectors using point-contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.

TEXT BOOKS:

1. Sabnesoloman, sensors & control systems in manufacturing Mc-Graw Hill book Company Network, 1994.
2. Mechatronics by Bolton

REFERENCES:

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

MERA 505B: ELECTIVE I- MICROCONTROLLERS AND SINGLE BOARD COMPUTERS				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	5 Hrs/Week	5	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Basic electronics			
Course Objective	1. Introduce low power microcontrollers and to develop the skill set of programming low power sensing applications. 2. Impart the knowledge of various peripheral related to sensing and communication using wired or wireless means. 3. Upgrade the students by introducing them Advanced ARM Cortex microcontrollers 4. Develop the skill set of students capture various kinds of sensor and present the output in J2ME applications			
Course Outcome	1. Design and develop embedded programs for low power microcontrollers for sensor applications. 2. Develop ARM basic and advanced programs. 3. Interface and deploy analog sensors 4. Interface digital sensors 5. Interface Bio medical sensors and develop logging systems 5. Develop communication system with sensor units			

UNIT I

Introduction to the concepts of microprocessors, microcontrollers, RISC, CISC, Harvard and Von Neumann architectures. Applications of microcontrollers. Microcontrollers: Introduction to Intel 8 bit &16 bit Microcontrollers, 8051- Architecture and pin details, Memory organization, Addressing Modes and exercises

UNIT II

Hardware description of 8051: Instruction formats, Instruction sets, interrupt Structure & interrupt priorities, Port structures & Operation linear counter Functions, different Modes of Operation and Programming examples.Features of machine language, assembly language, middle-level and high-level languages, Instruction set: Classification, syntax and function of instructions, example programs.

UNIT III

Features of I/O ports. Byte size I/O, bit addressability and configuring I/O ports, interface I/O devices such as LED, buzzer, push-button switch, relay, example programs with assembly & C. Polling & interrupt methods, executing an interrupt, different types, IE and IP registers, enabling, disabling and priority setting, example programs in assembly and C.

UNIT IV

Interfacing the 8051,LED Interfacing to Microcontroller, 7-Segment Display interfacing circuit, LCD Interfacing to Microcontroller, Stepper motor interfacing circuit, Matrix keypad interfacing to 8051.

UNIT V

Bit structure and function of TMOD and TCON registers, mode 1 & mode 2 operations of timers and counters, time delay generation & example programs in assembly and C.

MERA 505C: ELECTIVE I- MECHATRONICS

Teaching Scheme		Credits	Examination Scheme	
Theory	5 Hrs/Week	5	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	Sensors Technology, Robot Programming, Artificial Intelligence for Robotics			
Course Objectives	1. Understand key elements of Mechatronics system, representation into block diagram 2. Understand concept of transfer function, reduction and analysis 3. Understand principles of sensors, its characteristics, interfacing with D/A and microcontroller 4. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application 5. Understand the system modeling and analysis in time domain and frequency domain 6. Understand control actions such as Proportional, derivative and integral and study its significance in industrial applications			

Bit structure and function of SCON register, SBUF register, TI and RI flags, working of serial port, connecting 8051 to RS-232, serial data transmission and reception, example programs in assembly and C.

UNIT VI

Introduction to Raspberry PI and various models, Applications, Types and standards, difference between microcontroller and single board computer, Embedded system with single board computer and Microcontroller.

REFERENCES

1. Introduction to Embedded Systems: Shibu K.V. McGRAW Hill Publications
2. Embedded Systems: Raj Kamal, TATA McGRAW Hill Publications
3. Computer System Architecture: M. Morris Mano.
4. The 8051 Microcontroller & Embedded systems using assembly and C (2nd Edition) -M.A.Mazidi, J.C. Mazidi & R.D.McKinlay ISBN: 81-317-1026-2
5. The 8051 Microcontroller(4th Edition) – MacKenzie , ISBN:81-317-2018-7
6. The 8051 Microcontroller^ Edition) – Dr.Uma Rao.&AndhePaallayl, ISBN: 81-317-3252
7. Microcontrollers & applications, Ramani Kalpathi, & Ganesh Raja , ISBN: 81-888-4918-9

Course Outcomes	On completion of the course, students will be able to – 1. Identification of key elements of mechatronics system and its representation in terms of block diagram 2. Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O 3. Interfacing of Sensors, Actuators using appropriate DAQ micro-controller 4. Time and Frequency domain analysis of system model (for control application) 5. PID control implementation on real time systems 6. Development of PLC ladder programming and implementation of real life system.

UNIT I:Introduction to Mechatronics, Sensors &Actuators :Introduction to Mechatronics and its Applications; Measurement Characteristics: Static and Dynamic; Sensors: Position sensors- Potentiometer, LVDT, incremental Encoder; Proximity sensors-Optical, Inductive, Capacitive; Temperature sensor-RTD, Thermocouples; Force / Pressure Sensors-Strain gauges; Flow sensors-Electromagnetic; Actuators: Stepper motor, Servo motor, Solenoids; Selection of Sensor & Actuator

UNIT II:Block Diagram Representation,Introduction to Mechatronic System Design; Identification of key elements of Mechatronics systems and represent into Block Diagram; Open and Closed loop Control System; Concept of Transfer Function; Block Diagram & Reduction principles; Applications of Mechatronic systems: Household, Automotive, Industrial shop floor

UNIT III: Data Acquisition Introduction to Signal Communication & Types-Synchronous, Asynchronous, Serial, Parallel; Bit width, Sampling theorem, Aliasing, Sample and hold circuit, Sampling frequency; Interfacing of Sensors / Actuators to Data Acquisition system; 4 bit Successive Approximation type ADC; 4 bit R2R type DAC; Current and Voltage Amplifier.

UNIT IV:Programmable Logic Control Introduction to PLC; Architecture of PLC; Selection of PLC; Ladder Logic programming for different types of logic gates; Latching; Timers, Counter; Practical examples of Ladder Programming.

UNIT V: Frequency Domain Modelling and Analysis Transfer Function based modeling of Mechanical, Thermal and Fluid system; concept of Poles & Zeros; Stability Analysis using Routh Hurwitz Criterion; Bode Plots: Introduction to Bode Plot, Gain Margin, Phase Margin, Relative Stability Analysis, Frequency Domain Parameters-Natural Frequency, Damping Frequency and Damping Factor; Mapping of Pole Zero plot with damping factor, natural frequency and unit step response.

UNIT VI: Control System (Proportional (P), Integral (I) and Derivative (D) control actions; PI, PD and PID control systems in parallel form; Unit step Response analysis via Transient response specifications: Percentage overshoot, Rise time, Delay time, Steady state error; Manual tuning of PID control; Linear Quadratic Control (LQR).

TEXT BOOKS:

1. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008
2. Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall, 2009

REFERENCES:

1. Alciatore&Histand, Introduction to Mechatronics and Measurement system, 4th Edition, Mc-Graw Hill publication, 2011

2. Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006

3. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi

4. C. D. Johnson, Process Control Instrumentation Technology, Prentice Hall, New Delhi

MERA 505D: ELECTIVE I-CAD/CAM

Teaching Scheme		Credits	Examination Scheme	
Theory	5 Hrs/Week	5	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Basics of Engineering drawing			
Course Objective	1. Provide basic foundation in computer aided design / manufacturing. 2. Understand the fundamentals used to create and manipulate geometric models. 3. Get acquainted with the basic CAD software designed for geometric modeling. 4. Learn working principles of NC machines CNC control and part programming. 5. Understand concept of Group Technology, FMS and CIM.			
Course Outcome	1. Describe basic structure of CAD workstation, Memory types, input/output devices and display devices and computer graphics.			

	2. Acquire the knowledge of geometric modeling and Execute the steps required in CAD software for developing 2D and 3D models and perform transformations. 3. Explain fundamental and advanced features of CNC machines. 4. Illustrate Group Technology, CAQC and CIM concepts.

UNIT I: GEOMETRIC MODELLING: Surfaces, Representation of surfaces, types of surfaces, Coons patch surface, Bezier, B-Spline, NURBS Surface, Surface Modeling [Only Theory, No numerical.

UNIT-II THE INTRODUCTION AND SCOPE OF CIM : Introduction to CIM, definition of CIM, CIM wheel, evolution of CIM, development of numerical control, computers, computer–aided design (CAD), computer-aided manufacturing (CAM), islands of automation, evolution of the CIM concept, CIM II, benefits of CIM. Needs of CIM hardware, CIM software, CIM workstations.

UNIT-III REVERSE ENGINEERING: Introduction, Conversion of surface models into solid. Point cloud data for inspection and creating CAD models in CAD. CAT and CAI (e.g. CMM inspection, Machine Vision, RP etc.). Application based CAD modeling techniques.

UNIT IV FUNDAMENTALS OF COMMUNICATIONS: Introduction, information: types of communications. Fundamentals of computer communications, representation of data, coding, transmission, medium, types of communication lines, communications hardware. Network architectures - the seven layers-OSI model, local area network (LAN), manufacturing automation protocol (MAP).

UNIT V PRODUCT DESIGN: Needs of the market, design and engineering, the design process, computer-aided design (CAD), areas of application, benefits of CAD, computer graphics, CAD hardware and software, CAD/CAM workstations. Three-dimensional capabilities - principles of curve generation, representation of 3D surfaces, from CAD to CAM. CAE - finite element technique.

UNIT VI PRODUCTION PLANNING: Introduction, computer-aided cost estimating, production planning and control MRP II, History Of Group Technology, role of G.T in CAD/CAM Integration, part families classification and coding, DCLASS and MCLASS and OPTIZ coding systems, facility design using G.T, benefits of G.T , cellular manufacturing. Process planning - role of Process, planning in CAD/CAM Integration, approaches to computer aided process planning, variant approach and generative approaches.

TEXT BOOK

1. Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering - Prentice Hall India.
2. Nitin S. Gokhale, Practical Finite Element Analysis, Finite To Infinite; First Edition edition, ISBN-10: 8190619500 ISBN-13: 978-8190619509
3. S. K. Sinha, CNC Programming using Fanuc Custom Macro B, McGraw-Hill Professional
4. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill

REFERENCES:

1. Ibraim Zeid, Mastering CAD/CAM – Tata McGraw Hill Publishing Co. 2000

2. Segerling L. J. - Applied Finite Elements Analysis, John Wiley and Sons

3. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010

4. Rao P. N., Introduction to CAD/CAM Tata McGraw Hill Publishing Co.

5. B. S. Pabla, M. Adithan, CNC Machines, New Age International, 1994

6. Groover M.P.-Automation, production systems and computer integrated manufacturing‘ - Prentice Hall of India

MERA506:LAB PRACTICE - I				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite: Knowledge of programming languages, Basics of Microcontroller				
Companion Courses: MERA 503 MERA505A MERA505B MERA505C MERA505D				
All assignments are compulsory. Each student should implement the assignment individually. Laboratory teachers should make sure that the example/dataset/code is not the same.				

Any 3 experiments from the following

1. Data movement:
    a. Move a block of data within internal RAM
    b. Exchange a block of data between internal RAM and external memory 3
2. Arithmetic operations:
    a. Evaluate simple arithmetic expression such as y= (((5*2)-(4+1))/3) %2.
    b. Addition of three 8-bit BCD numbers to result in BCD form. 3
3. Logical operations:
    a. Evaluate simple logical expression such as Y= a&&b^cA!dwhere a, b, c and dare 8-bit data
    b. Rotation or shift operations on 16-bit data
    c. Convert data to even-parity in a block of internal RAM 6
4. Code conversions
    a. Packed BCD to unpacked BCD and vice-versa
    b. BCD to binary and vice-versa
    c. BCD to ASCII and vice-versa 6
5. Program to search a given 8-bit number in an array of N numbers 3
6. Program to sort N 8-bit numbers. 3

Any 2 experiments from the following

1. Study of control system components
2. An experiment on speed control on stepper motor
3. An experiment level control system
4. An experiment ON/OFF temperature control
5. An experiment on various models of control I. P, P + I, P + D, P + I + D
6. Obtain frequency response of a given system by using various methods: (a)General method of finding the frequency domain specifications. (b) Polar plot (c) Bode plot Also obtain the Gain margin and Phase margin.

List of Experiments: Introduction and different features of the CAD Software. (Any 3 experiments from listed)

1. 3-D Modeling.
2. Assembly modeling.
3. Feature Modification and Manipulation
4. Sheet Metal Operations.
5. Surface Modeling
6. To prepare part program in inch mode for plain turning operation.
7. To prepare part program for taper turning operation.

REFERENCES

1. Introduction to Embedded Systems: Shibu K V, McGRAW Hill Publications.
2. Embedded Systems: Raj Kamal, TATA McGRAW Hill Publications
3. Computer System Architecture: M. Morris Mano.
4. The 8051 Microcontroller & Embedded systemsusing assembly and C (2^{nd}Edition) -M.A.Mazidi
5. Martenson, E. Micheal, “Geometric Modelling”, John Wiley & Sons, 1995.
6. Hill Jr, F.S., “Computer Graphics using open GL”, Pearson Education, 2003.

SEMESTER-II

MERA507: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR ROBOTICS				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Discrete Mathematics, data analytics, programming languages.			
Course Objectives:	1. To provide an introduction to the basic principles, techniques, and applications of Artificial Intelligence.			

	2. To know about Lisp and Prolog and use of these languages in AI. Students are expected to develop some familiarity with current research problems and research methods in AI by working on a research or design project.
Course Outcomes:	1. Able to describe human intelligence and AI. 2. Able to explain how intelligent system works. 3. Able to develop some familiarity with current research problems and research methods in AI. Able to demonstrate and illustrate about functionalities of Robots and Robotics.

UNIT-I INTRODUCTION: The foundations of AI, The History of AI, Intelligent agents, Agent based system. PROBLEM SOLVING:State Space models, Searching for solution, Uninformed / Blind search - Informed/ Heuristic search, A search Hill climbing search, Genetic Algorithm, Markovian Decision Process (MDP), Maximum value policies, Adversarial games, value/policy iteration, Minimax, Alpha-beta pruning, Temporal difference (TD), Constraint satisfaction problem, factor graphs, Backtracking search.

UNIT-II KNOWLEDGE REPRESENTATION AND REASONING: Knowledge representation, Logics, First order logic, Inference in first order logic, Higher order logic, Markov logic.

UNIT-III UNCERTAIN KNOWLEDGE AND PROBABILISTIC REASONING: Uncertainty, Probabilistic reasoning, Semantics of Bayesian network, Exact inference in Bayesian network, Approximate inference in Bayesian network, Direct sampling methods, Inference by Markov chain simulation, Probabilistic reasoning over time Hidden Markov Models.

UNIT-IV DECISION-MAKING: basics of utility theory, sequential decision problems, decision network policy, Decision process in infinite horizon: Optimal policy, Value iteration, policy iteration, Partially observable decision process, Decisions in Multi agent system: elementary game theory.

UNIT-V INTRODUCTION: Machine learning, Varieties of Machine learning, Learning Input-Output functions: Types of learning, Input Vectors, Outputs, Training regimes, Noise, Performance, Evaluation.

FOUNDATIONS OF SUPERVISED LEARNING: Decision trees and inductive bias, Geometry and nearest neighbors, Logistic regression, Perceptron, Binary classification.

UNIT-VI ADVANCED SUPERVISED LEARNING: Linear models and gradient descent, Support Vector machines, Naïve Bayes models and probabilistic modeling, Model selection and feature selection, Model Complexity and Regularization.

CASE STUDY 1: Line following using Supervised Learning techniques.

Goal: A simulation model will be developed for understanding both regression and classification techniques. A framework need to be fixed and the complexity of the model will be varied in order to analyse the effect on the system. The effectiveness of the Bias-variance has to be studied.

UNIT-VII UNSUPERVISED LEARNING: Curse of dimensionality, Dimensionality Reduction, PCA, Clustering K-means, Expectation Maximization Algorithm, Mixtures of latent variable models, Supervised learning after clustering, Hierarchical clustering.

NEURAL NETWORKS: Network Representation**,** Feed-forward Networks, Back propagation, Gradient-descent method.

TEXT BOOKS:

1. Stuart Russell, Artificial Intelligence: A Modern Approach, Pearson Education, 2014.
2. David Pool, Artificial Intelligence: Foundations of Computational agents‖, Cambridge, 2011.
3. Daphne Koller, Probabilistic Graphical Models - Principles and Techniques‖, MIT, 2009.
4. Tsang, Foundations of Constraint Satisfaction: The Classic Text‖, BoD–Books on Demand, 2014.
5. Tom Mitchell, Machine Learning‘, McGraw Hill, 1997.

6. Peter Flach, Machine Learning: The Art and Science of Algorithms, Cambridge, 2014.

REFERENCES:

1. Christopher M.Bishop, Pattern Recognition and Machine Learning‖, Springer, 2013.
2. Nils J. Nilsson, The Quest for Artificial Intelligence: A History of Ideas and achievements‖, Cambridge University Press, 2010.
3.Hal Daume III, A course in Machine Learning‘, Todo, 2015.
4. EthemAlpaydin,‘Introduction to Machine Learning‘, The MIT Press, 2004
5. David MacKay, Information Theory, Inference and Learning Algorithms‘, Cambridge, 2003

MERA508: DIGITAL SIGNALAND VIDEO PROCESSING				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Digital Signal Processing.			
	1. To study the image fundamentals and mathematical transforms necessary for image processing.			

	2. To understand various schemes for digital filter implementations. 3. To study different DSP algorithms for computation of DFT. 4. To study about the DSP Processor. 5. To learn the finite word length effects in signal processing. To understand various application areas using Signal processing methods.
	1. Review the fundamental concepts of a digital image processing system. 2. Gain knowledge on Digital Systems. 3. Ability to realize advanced FIR and IIR filter algorithms. 4. Ability to implement fast algorithms in the area of Digital Signal Processing. 5. Capability to analyze and implement the algorithms in finite word length systems. Able to apply Digital Signal Processing knowledge in specific domains.

UNIT-I Introduction and Classification of signals, Elementary signals used for testing, Basics of 1. Operations on signals, 2. Time domain representation of LTI System 3. Fourier Series and Transform 4. Laplace transform and its applications 5. Probability and Random Signals.

UNIT-II Sampling, DT signals, sampling theorem in time domain, sampling of analog signals, recovery of analog signals, and analytical treatment with examples, mapping between analog frequencies to digital frequency, representation of signals as vectors, concept of Basis function and orthogonality. Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing. Basics of 1. Discrete Fourier Transform 2. Z transform 3.FIR & IIR Filter Design 4. Multi-rate DSP and Introduction to DSP Processor

UNIT-III Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms Image Processing Techniques: Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering

UNIT-IV : Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region-based segmentation Image Compression Image compression fundamentals – coding Redundancy, spatial and temporal redundancy. Compression models: Lossy and Lossless, Huffmanncoding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding, wavelet coding, JPEG standards

UNIT-V Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models: 3D motion models, Geometric Image formation, Photometric Image formation, sampling of video signals, filtering operations

UNIT-VI 2-D Motion Estimation: Optical flow, general methodologies, pixel-based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding..

TEXT BOOKS:

1. ShailaApte, “Signals and Systems-principles and applications”, Cambridge press, 2016.
2. A. NagoorKanni “Signals and Systems”, 2nd edition, Mc Graw Hill.
3. Peyton Peebles, “Probability, Random Variable, Random Processes”, Tata Mc Graw Hill.
4. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, algorithms and applications” Fourth edition, Pearson Prentice Hall.
5. S. Salivahanan, C. Gnanpriya, “Digital Signal processing”, McGraw Hill .
6. Gonzaleze and Woods,Digital Image Processing, 3rd edition, Pearson

MERA 509: ROBOTICS OPERATING SYSTEM				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	**Mathematical prerequisites:** Students taking this course will be expected to have some familiarity with linear algebra, single variable calculus, and differential equations. **Programming prerequisites:** Some experience programming with			

	MATLAB or Octave is recommended (we will use MATLAB in this

MERA 510 A: ELECTIVE II: ADDITIVE MANUFACTURING & TOOLING

Teaching Scheme		Credits	Examination Scheme	
Theory	4 Hrs/Week	4	In Semester	50 Marks
			End Semester	50 Marks
Prerequisite	Machining and Machine tool Technology			
Course Objective	1. To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering			
Course Outcomes	1. Describe the need for ROS and its significance. 2. Summarize the Linux commands used in robotics. 3. Discuss about the concepts behind navigation through filesystem. 4. Explain the concepts of Node debugging. 5. Analyze the issues in hardware interfacing. 6. Discuss about the applications of ROS.			

UNIT-I BASICS OF ROBOTICS: History – Definition – Components – Building a robot – The Robot drive mechanism.
UNIT -II ROBOT SIMULATION: Mathematical modeling of the robot - Robot kinematics – Concepts of ROS and Gazebo.
UNIT- III DESIGNING CHEFBOT HARDWARE: Specifications - Block diagram - Working with Robotic Actuators and Wheel Encoders - Interfacing DC geared motor with Tiva C Launch Pad - Interfacing quadrature encoder with Tiva C Launchpad - Working with Dynamixel actuators.
UNIT-IV WORKING WITH ROBOTIC SENSORS: Working with ultrasonic distance sensors - Working with the IR proximity sensor - Working with Inertial Measurement Unit.
UNIT-V PYTHON AND ROS: Introduction to OpenCV, OpenNI, and PCL - Programming Kinect with Python using ROS, OpenCV, and OpenNI - Working with Point Clouds using Kinect, ROS, OpenNI, and PCL.
UNIT-VI INTERFACING IT INTO ROS, USING PYTHON: Building ChefBot hardware - Writing a ROS Python driver for ChefBot - Understanding ChefBot ROS launch files - Working with ChefBot Python nodes and launch files - The Calibration and Testing of ChefBot - The Calibration of Xbox Kinect using ROS - Wheel odometry calibration - Testing of the robot using GUI.
TEXT BOOKS: 1. Lentin Joseph, Learning Robotics using Python‖, PACKT Publishing, 2015. 2. Aaron Martinez and Enrique Fernandez, Learning ROS for Robotics Programming‖, PACKT Publishing, 2013.
REFERENCE: 1. Bill Smart, Brian Gerkey, Morgan Quigley, Programming Robots with ROS: A Practical Introduction to the Robot Operating System‖, O'Reilly Publishers, 2015

	techniques. 2. To familiarize students with different processes in rapid prototyping systems. 3. To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.
Course Outcome	1. Demonstrate the knowledge of Additive Manufacturing and RapidPrototyping technologies. 2. Describe different RP techniques. 3. Discuss fundamentals of Reverse Engineering.
UNIT I - Introduction: Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping processchains, 3D modeling and mesh generation, Data conversion and transmission.	
UNIT II - RP Systems: Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RPsystems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling systems etc .,	
UNIT III: Power based rapid prototyping systems, selective Laser sintering, SoligenDiren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.	
UNIT IV - RP Database: Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations,Digital inspection, Data warehousing and learning from process data.	
UNIT V - RP Applications: Development of dies for moulding, RP applications in developing prototypes of products, application in medical fields, Development of bone replacements and tissues, etc., RP materials and their biological acceptability	
TEXT BOOKS: 1. Rapid Prototyping Of Digital Systems: A Tutorial Approach, Hamblen James O , Kluwer Aca 2. 2. Rapid Prototyping: Principles And Applications, Kai Chua Chee, World Science	
REFERENCES: **1.** Rapid System Prototyping WithFpgas: Accelerating The Design Process, R C Cofer, Newnes **2.** Rapid Prototyping of Digital Systems, James O Hamblen, Springer	

MERA 510 B: ELECTIVE II: INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEM

Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Basic knowledge about working of sensors. Basics of Strength of Materials/ Engineering Mechanics. Basics of Mathematical Calculations.			
Course	1. To introduce the basic concepts, parts of robots and types of robots.			

Objective	2. To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots. 3. To discuss about the various applications of robots, justification and implementation of robot.
Course Outcomes	1. Learn about the basic concepts, parts of robots and types of robots. 2. To design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming. 3. Ability in selecting the required robot 4. Know various applications of robots 5. Apply their knowledge in handling the materials.

Unit I INTRODUCTION: Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell, Data-Processing Software and Robot Languages.

Unit II ROBOT GRIPPERS / END EFFECTORS: Gripper force analysis and gripper design for typical applications, design of multiple degrees of freedom, active and passive grippers, actuation mechanisms based on gripper forces.

Unit III SELECTION OF ROBOT: Factors influencing the choice of a robot, robot performance testing, economics of robotization, Impact of robot on industry and society. Decision-Making System of Robots, Decision Making for Autonomous Behaviors, Image-Guided Motion Planning and Control.

Unit IV ROBOTS FOR INSPECTION: Robotic vision systems, image representation, image processing- object recognition and categorization, depth measurement, image data compression, Visual inspection, software considerations.

Unit V OTHER APPLICATIONS: Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications, aerial robotics and intelligent vehicles.

Unit VI MATERIAL HANDLING : Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems –industrial trucks, monorails, rail guided vehicles, conveyor systems, cranes and hoists, advanced material handling systems, automated guided vehicle systems(AGVS), automated storage and retrieval systems(ASRS), barcode technology, radio frequency identification technology. Introduction to Automation Plant design software's.

TEXTBOOKS:

1. Klafter Richard D, Thomas Achmielewskiand, Mickael Negin— Robotic Engineering – An integrated Approach, Prentice Hall India, New Delhi, 2001.
2. Groover Mikell P, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.

REFERENCES:

1. Rehg James A —Introduction to Robotics in CIM Systems, Prentice Hall of India, 2002.
2. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994.
3. Xie Ming, Fundamentals of Robotics, Series in machine perception and artificial intelligence, Vol.54, World Scientific Publishing Co. Pvt. Ltd. 2003.

MERA 510 C: ELECTIVE II: KINEMATICS AND DYNAMICS OF ROBOTS

Teaching Scheme		Credits	Examination Scheme	
Theory	4 Hrs/Week	4	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Calculus of Variations, Computer Aided Geometry/design.			

MERA 510 D: ELECTIVE II: FLEXIBLE MANUFACTURING SYSTEM

Objectives:	2. To develop the ability to analyze and design the motion for articulated systems. 3. To develop an ability to use software tools for analysis and design of robotic systems		
Teaching Scheme	**Credits**	**Examination Scheme**	
Theory 4 Hrs/Week	4	**In Semester**	50 Marks
		End Semester	50 Marks
Course Outcomes:	1. Be able to calculate the Jacobian for serial and parallel robot. 2. Be able to do the path planning for a robotic system. 3. Be able to use matrix algebra and Lie algebra for computing the kinematics of robots.		

UNIT-I INTRODUCTION: Specifications of Robots- Classifications of robots – Work envelope - Flexible automation versus Robotic technology – Applications of Robots. Basic Mechanism:Definitions: Link, Kinematic pair, Kinematic chain, Mechanism and Machine - Degree of freedom – Mobility – Kutzbach criteria –Grashoff's law - Kinematic inversions: Four bar and slider crank mechanism - Mechanical advantage - Transmission angle - Description of common mechanisms, applications of mechanisms.

UNIT-II KINEMATIC ANALYSIS: Displacement, velocity and acceleration analysis in simple mechanisms using graphical and analytical methods.

UNIT-III DIRECT & INVERSE KINEMATICS: Dot and cross products, Co-ordinate frames, Rotations, Homogeneous Coordinates, Link co-ordinates, D-H Representation, Arm equation -Two axis, three axis, four axis, five axis and six axis robots**.** Inverse Kinematic problem, General properties of solutions, Tool configuration, Inverse Kinematics of Two, Three ,Four axis and Five axis robots.

UNIT-IV WORKSPACE ANALYSIS: Workspace analysis of Four axis, Five axis and Six axis robots, Perspective transformation, structured illumination, Camera calibration, Work envelope of Four and Five axis robots, Workspace fixtures.

UNIT-V DIFFERENTIAL MOTION AND STATICS: The tool Configuration jacobian matrix for three axis and, four axis robots, joint space singularities, resolved motion rate control, manipulator jacobian for three and four axis joint space singularities, induced joint torques and forces**.**

UNIT-VI DYNAMIC ANALYSIS AND FORCES: Introduction, Langrangian mechanics, Effects of moments of Inertia, Dynamic equation for two axis planar articulated robot. Trajectory planning, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion**.**

TEXT BOOKS:

1. Schilling Robert J. ―Fundamentals of Robotics Analysis and Control‖, PHI Learning, 2009.
2. Niku S B ―Introduction to Robotics, Analysis, Systems, Applications‖, Prentice Hall, 2001.

REFERENCES:

1. Craig John J, ―Introduction to Robotics‖, Pearson, 2009.
2. Deb S R and Deb S, ―Robotics Technology and Flexible Automation‖, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Klafter Richard D, Thomas A Chmielewski, Michael Negin, Robotics Engineering – An Integrated Approach, Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Saha S K, ―Introduction to Robotics‖, Tata McGraw Hill Education Pvt. Ltd, 2010.

Prerequisite	-
Course Objective	1. To expose the student to the different types of manufacturing available today such as the Special Manufacturing System, the Manufacturing Cell, and the Flexible Manufacturing System (FMS), 2. To learn the fundamentals of computer assisted numerical control programming and programming languages, 3. The common CAD/CAM data base organized to serve both design and manufacturing
Course Outcome	1. Ability to perform Planning, Scheduling and control of Flexible Manufacturing systems 2. Perform simulation on software's use of group technology to product classification 3. Perform design on software's use of group technology to machine classification

UNIT I Introduction: FMS definition and classification of manufacturing systems, automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

UNIT II : FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines,

UNIT III :FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment. Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part-machine group analysis,

UNIT IV Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular Vs FMS production. FMS related problem and Solution Methodology:

UNIT V: FMS Design Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks.

UNIT VI : FMS Planning: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems. • Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control. • FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

TEXT BOOKS:

1. Automation, Production System & Computer Integrated Manufacturing Groover Englewood
2. Design and Operation of SMS Rankey IFS
3. Flexible Manufacturing System Wernecks Spring-Verlag

REFERENCES:

1. FMS in Practice Bonctto Northox Ford
2. Flexible Manufacturing Cells and systems W.W. Luggen Prentice Hall India
4. Performance Modelling of Automated Manufacturing Vishwanathan &Narahar Prentice Hall

India

MERA 511: SEMINAR - I

<table>
<tr><th colspan="2">Teaching Scheme</th><th>Credits</th><th colspan="2">Examination Scheme</th></tr>
<tr><td>Theory</td><td>04 Hrs/Week</td><td>4</td><td>TW
OR/PRE</td><td>50 Marks
50 Marks</td></tr>
<tr><td>Course Objective</td><td colspan="4">1. To identify the domain of research
2. To learn to communicate in a scientific language through collaboration with a guide.
3. To categorize the research material confined to the domain of choice
4. To work in professional environment</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">Course Outcomes: On completion of the course, learner will be able to–
CO1: Conduct thorough literature survey confined to the domain of choice
CO2: Develop presentation skills to deliver the technical contents
CO3: Furnish the report of the technical research domain
CO4: Analyze the findings and work of various authors confined to the chosen domain</td></tr>
<tr><td colspan="5">Conduction guidelines
Industry or research internship/ seminar should include partial/complete project implementation. Student should be allocated to the research guide in first semester itself and same guide should be continued for the: Industry Internship-I/ Seminar / In house Research Project –I.
Otherwise the preferences/choices of the domain should be taken from the students. The guide needs to be allocated based on the preference/choices. The research project should be assigned to students. In case of Industry Internship-I, the assigned guide from college has to monitor and evaluate the progress of the student. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation. The continuous assessment of the progress needs to be documented unambiguously.</td></tr>
</table>

MERA512:LAB PRACTICE - II				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	4 Hrs/Week	4	**In Semester**	50 Marks
			End Semester	50 Marks

Prerequisite: Knowledge of programming languages, Basics of Microcontroller

Companion Courses:
MERA 507
MERA 508
MERA510A
MERA510B
MERA510C
MERA510D

All assignments are compulsory. Each student should implement the assignment individually. Laboratory teachers should make sure that the example/dataset/code is not the same.

Any 3 experiments from the following

Digital Signal Processing

1. a. Implement the sampling theorem and aliasing effects by sampling an analog signal with various sampling frequencies b. To study the circular convolution for calculation of linear convolution and aliasing effect.
2. a. To study the properties of DFT., Write programs to confirm all DFT properties Write a program to find 4-point circular convolution b. Compare the result with 8-point circular convolution to study aliasing in time domain.
3. a. To find Z and inverse Z transform and pole zero plot of Z-transfer function. b. To solve the difference equation and find the system response using Z transform.
4. Perform global and adaptive thresholding.
5. Extraction of frames from video, improve the quality and convert them back to compressed video.
6. Write as code for finding disparity for stereo images using SSD algorithm coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding, wavelet coding, JPEG standards

Any 2 experiments from the following: Lab assignments will be provided for all the topics given below.
1. Algorithm for 8 –puzzle and Missionaries and Cannibals problem.
2. Hill climbing and genetic algorithm
3. Constraint satisfaction techniques,
4. Simple games – minimax and expect Imax
5. Logic based exercises.

List of Experiments: Any 3 experiments from the following
Operating System recommended: - 64-bit Open source Linux or its derivative Programming Languages: C++/JAVA/PYTHON/R Programming Tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend: MongoDB/MYSQL/Oracle, Database Connectivity:

ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

1. We have given a collection of 8 points. P1=[0.1,0.6] P2=[0.15,0.71] P3=[0.08,0.9] P4=[0.16, 0.85] P5=[0.2,0.3] P6=[0.25,0.5] P7=[0.24,0.1] P8=[0.3,0.2]. Perform the k-means clustering with initial centroids as m1=P1 =Cluster#1=C1 and m2=P8=cluster#2=C2. Answer the following
   1] Which cluster does P6 belongs to?
   2] What is the population of cluster around m2?
   3] What is updated value of m1 and m2?
2. Apply the Principal Component Analysis for feature reduction on any Company Stock Market Dataset
3. Implement Tic-Tac-Toe using A* algorithm
4. Solve 8-puzzle problem using A* algorithm. Assume any initial configuration and define goal configuration clearly
5. Develop elementary chat bot for suggesting investment as per the customers need.
6. Use Heuristic Search Techniques to Implement Hill-Climbing Algorithm

REFERENCES

1. ApteShaila, Signals and Systems-principles and applications, Cambridge press, 2016.
2. NagoorKanni A. Signals and Systems, 2nd edition, Mc Graw Hill.
3. Peyton Peebles, Probability, Random Variable, Random Processes, Tata Mc Graw Hill.
4. Schilling Robert J. ―Fundamentals of Robotics Analysis and Control‖, PHI Learning, 2009.
5. Niku S B ―Introduction to Robotics, Analysis, Systems, Applications‖, Prentice Hall, 2001.
6. Bonaccorso Giuseppe, Machine Learning Algorithms, Packt Publishing Limited, ISBN-10: 1785889621, ISBN-13: 978-1785889622
7. Flach Peter, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, Edition 2012, ISBN-10: 1107422221; ISBN-13: 978-1107422223
8. Rich Elaine, Knight Kevin and Nair, “Artificial Intelligence”, TMH, ISBN-978-0-07-008770-5

SEMESTER-III

<table>
<tr><th colspan="5">MERA 513:ROBOTICS APPLICATIONS</th></tr>
<tr><td colspan="2">Teaching Scheme</td><td>Credits</td><td colspan="2">Examination Scheme</td></tr>
<tr><td>Theory</td><td>4 Hrs/Week</td><td>4</td><td>In Semester
End Semester</td><td>50 Marks
50 Marks</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Mechatronics.</td></tr>
<tr><td>Course Objective</td><td colspan="4">1. To understand the basic concepts associated with the design and Functioning and applications of Robots.
2. To study about the drives and sensors used in Robots.
3. To learn about analyzing robot kinematics and robot programming.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4">1. Upon completion of this course, the students can able to apply the basic engineering.
2. To learn about knowledge for the design of robotics.
3. Will understand robot kinematics and robot programming.
4. Will understand application of Robots.
5. To learn about force and torque sensing.
6. To learn about application of robot.</td></tr>
<tr><td colspan="5">Unit I INTRODUCTION: History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot</td></tr>
<tr><td colspan="5">Unit II DRIVE SYSTEMS AND SENSORS : Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors</td></tr>
<tr><td colspan="5">Unit III KINEMATICS AND DYNAMICS OF ROBOTS: 2D, 3D Transformation, scaling, rotation, translation, homogeneous coordinates, multiple transformation, simple problems. matrix representation, forward and reverse kinematics of three degree of freedom, homogeneous transformations, inverse kinematics of robot, robot arm dynamics, d-h representation of robots, basics of trajectory planning</td></tr>
<tr><td colspan="5">Unit IV MANIPULATORS CONSTRUCTION OF MANIPULATORS: Manipulators Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators Classification of End effectors – Tools as end effectors. Drive system for grippers-Mechanical adhesive-vacuum-magnetic-grippers. Hooks & scoops. Gripper force analysis and gripper design. Active and passive grippers</td></tr>
<tr><td colspan="5">Unit V PATH PLANNING &PROGRAMMING :Path planning & Programming Trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion – straight line motion-Robot languages-computer control and Robot software</td></tr>
<tr><td colspan="5">Unit VI ROBOT CONTROL, PROGRAMMING AND APPLICATIONS : Robot Control, Programming and Applications Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples. Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting</td></tr>
</table>

Text Books:

1. Groover Mikell P, Odrey Nicholas G, Weiss Mitchel, Nagel Roger N, Dutta Ashish, “Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
2. Craig. J. J. “Introduction to Robotics- mechanics and control”, Addison- Wesley, 1999.

Reference Books:

1. Deb S.R., “Robotics Technology and flexible automation”, Tata McGraw-Hill, 2009.
2. Klafter Richard D., ChriElewskiThomas .A, Negin Michael, "Robotics Engineering an Integrated Approach", PHI Learning, 2009.
3. Nagy Francis N., Siegler Andras, “Engineering foundation of Robotics", Prentice, 1987.
4. Janaki Raman P.A, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.

MERA 514 AUTOMATIC CONTROL AND POWER SYSTEMS

Teaching Scheme		Credits	Examination Scheme	
Theory	4 Hrs/Week	4	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite	Basic Electrical Engineering/Basic Electronics Engineering			
Course Objectives:	1. To understand basic concepts of the classical control theory. 2. To model physical systems mathematically. 3. To analyze behaviour of system in time and frequency domain.			
Course Outcomes:	On completion of the course, students will be able to 1. Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O 2. Time and Frequency domain analysis of system model (for control application) 3. PID control implementation on real time 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, Thermal, Hydraulic systems and Electrical Systems - Transfer function of DC servomotor, AC servomotor, Potentiometer, Tacho-generator, Stepper motor - 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.

UNIT-III 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.

UNIT-IV FREQUENCY RESPONSE OF SYSTEMS: Frequency domain specifications, Estimation for second order systems, Correlation between time and frequency domain specifications for second order systems.

UNIT-V SYSTEM STABILITY: Concept of stability, stability & location of the poles in S-plane, Characteristic equation, Routh-Hurwitz stability criterion, Root Locus concepts

UNIT-VI FREQUENCY DOMAIN ANALYSIS: 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.

TEXT BOOKS:

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

REFERENCES:

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

MERA 515 A :ELECTIVEIII :INTERNET OF THINGS				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	5 Hrs/Week	5	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	Embedded systems, Networking, Computer programming, Big data.			
Course Objective	2. Students will be explored to the interconnection and integration of the physical world and the cyber space. 3. They are also able to design & develop IOT Devices.			
Course Outcomes	1. Able to understand the application areas of IOT. 2. Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor networks. 3. Able to understand building blocks of Internet of Things and characteristics.			

UNIT-I INTRODUCTION TO IOT: Definition and Overview, History, Physical design, Logical design, Levels, communication technologies, Applications. Energy Monitoring and Control Device, legal and security aspects.

UNIT-II NETWORKING: Client/Server Model, An overview of internet communications: IP Address, MAC addresses, TCP and UDP protocols, Application Layer Protocols, AT Commands.

UNIT-III MIDDLEWARE FOR IOT: Platform middleware, Embedded IoT Devices, communication middleware, M2M, RFID, WSN, SCADA, software middleware, Frameworks, Data standards, IoT information Security, Challenges.

UNIT-IV IOT DESIGN METHODOLOGY: Purpose, requirements, process-domain, information, service, function, operation, component integration, Application development.

UNIT-V CLOUD OF THINGS: Introduction to Cloud Storage Models, Grid, SOA, cloud computing, cloud middleware, mobile cloud, Could of Things Architecture, Big-Data Analytics and Visualization, Dependability, Security, Maintainability, IoT Standards.

UNIT-VI CASE STUDIES: IoT System for weather monitoring-IoT System for home automation-Wi-Fi-controlled Mobile Robot – Remote.

TEXT BOOKS:

1. Zhou Honbo, The Internet of Things in the Cloud A Middleware Perspective‖, CRC Press, 2013.
2. Ewen Adrain Mc, Hakim Classically, Designing the Internet of Things‖, Wiley, 2014.

REFERENCES:

1. Schwartz Marco, Internet of Things with the Arduino Yun‖, Packt Publishing, 2014.
2. BahgaArshdeep, Madisetti Vijay K., Internet of Things A Hands-on Approach‖, VPT, 2014.
3. Weber Rolf H., Weber Romana, Internet of Things Legal Perspectives‖, Springer 2010, ISBN 978-3-642-11709-1.

MERA 515 B ELECTIVEIII :BLOCK CHAIN TECHNOLOGY

Teaching Scheme		Credits	Examination Scheme	
Practical	5 Hrs/Week	5	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	Introduction to algorithm, network security, Database and big data.			
Course Objective	1. Understand how blockchain systems work, to securely interact with them, 2. Design, build, and deploy smart contracts and distributed applications, 3. Integrate ideas from blockchain technology into their own projects.			
Course Outcomes	1. Explain design principles of Bitcoin and Ethereum. 2. List and describe differences between proof-of-work and proof-of-stake consensus. 3. Interact with a blockchain system by sending and reading transactions. 4. Design, build, and deploy a distributed application. 5. Evaluate security, privacy, and efficiency of a given blockchain system.			

Unit-I

Course overview, Bitcoin The big picture of the industry – size, growth, structure, players. Bitcoin versus Cryptocurrencies versus Block chain, Distributed Ledger Technology (DLT). Strategic analysis of the space – who are the major players (Block chain platforms, regulators, application providers, etc.) Bitcoin, Hyper Ledger, Ethereum, Lit coin, Zcash. Etc. The major application: currency, identity, chain of custody.

Unit-II

Trust and Vulnerability Short history of the scaling out of human trust. High and Low trust societies Types of Trust model: Peer-to-Peer, Leviathan, and Intermediary. Introduction to Cryptography. Brief history, and goals of cryptography Symmetric-key cryptography Public-key cryptography Digital Signatures, Hash Functions

Unit-III

The history of money – why it exists, what it does, why people care, where it is going? Money as a store of value versus money for transactions (buying goods and service). Asset backed currency, gold standard, Bretton-Woods, hyper-inflation. Modelling money flow (velocity of money) Application of Cryptography to Block chain, using hash functions to chain blocks, Digital Signatures to sign transactions, Using hash functions for Proof-of-Work.

Unit-IV

Consensus mechanisms – distributed trust in data. Introduction to crypto economics there (proof of work and proof of stake), as well as the distinction between those models and non-economic solutions like PBFT, Ripple's approach, and others). Byzantine agreement, Extensions of BFT (Ripple, Stellar), Block chain Dynamics, Public and private block chains, Hard and soft forks, Sharding Side chains

Unit-V

Basics of contract law. Smart contracts and their potential Trust in Algorithms, the impact on society. How existing legal systems could be integrated? OpenZeplin, Open Law. Basics of contract law. Smart contracts and their potential Trust in Algorithms, the impact on society. How existing legal systems could be integrated

Unit-VI

Assets (fiat currencies, property, equity, securities). Supply and demand. Inflation and deflation Valuations and bubbles. Cyrptoeconomics – moving beyond its use in verifying the block chain– motivating participants, creating investment funds, storing value Creating and using tokens and coins.

References:

1. Melanie Swan, "Block chain: Blueprint for a New Economy", O'Reilly Publication.
2. Bonneau Joseph et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015.
3. Pass R. et al, Analysis of Block chain protocol in Asynchronous networks, EUROCRYPT 2017, (eprint.iacr.org/2016/454).

MERA 515 C: ELECTIVE III CLOD COMPUTING				
Teaching Scheme:		**Credits**	**Examination Scheme**	
Theory	5 Hrs/Week	5	**In Semester** **End Semester**	50 Marks 50 Marks
Prerequisite:	Concepts from Operating Systems, Computer Network			
Course Objectives:	1. To understand Basics of Cloud Computing. 2. To understand Structure of Cloud Computing. 3. To know applications of Cloud Computing.			
Course Outcomes:	1. Summarize different types of clouds and their applications. 2. Draw and Compare different Architectures of Cloud. 3. Analyze Problems in Cloud Security and Management. 4. To install cloud computing Environment. 5. To develop cloud computing Application.			
Unit IBasics of Cloud Computing: Overview, Applications, Intranets and the Cloud. Your Organization and Cloud Computing- Benefits, Limitations, Security Concerns. Software as a Service (SaaS) - Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Benefits of Paas Solutions, Disadvantages of PaaS Solutions. Infrastructure as a Service (IaaS)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages and Server Types.				
Unit II Data Storage and Security in Cloud:Cloud file systems: GFS and HDFS, Big Table, Base and Dynamo Cloud data stores: Data store and Simple DB Gautam Shrauf, Cloud Storage-Overview, Cloud Storage Providers. Securing the Cloud- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Disaster Recovery- Understanding the Threats.				
Unit III Virtualization: Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Types of Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation. Common Standards: The Open Cloud Consortium, Open Virtualization Format, Standards for Application Developers: Browsers (Ajax), Data (XML, JSON), Solution Stacks (LAMP and LAPP), Syndication (Atom, Atom Publishing Protocol, and RSS) and Standards for Security.				
Unit IVCloud Security:Security Challenges in Cloud : Deployment, Service, Network , Cloud Information Security Fundamentals, Cloud Information Architecture: Information Dispersion, Information Management, Data Security Life Cycle, Information Governance, Data Security, Data Loss Prevention, Cloud Security Services, Cloud Security Architecture: Design, Requirement, Implementation				
Unit V Ubiquitous Clouds and the Internet of Things: Cloud Trends in Supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud, Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS), Innovative Applications of the Internet of Things (Smart Buildings and Smart Power Grid, Retailing and Supply-Chain Management, Cyber-Physical System), Online Social and Professional Networking.				

Unit VIFuture of Cloud Computing:Change in Operating Systems, Location-Aware Applications, Intelligent Fabrics, Paints, and More, The Future of Cloud TV, Future of Cloud-Based Smart Devices, Faster Time to Market for Software Applications, Home-Based Cloud Computing, Mobile Cloud, Autonomic Cloud Engine, Multimedia Cloud, Energy Aware Cloud Computing, Jungle Computing. **Docker at a Glance**: Process Simplification, Broad Support and Adoption, Architecture, Getting the Most from Docker, The Docker Workflow.
Text Books: 1. Velte Anthony T.,Velte, Toby J. Elsenpeter Robert, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill. 2. Dr. Jamsa Kris, " Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more" , Wiley Publications, ISBN: 978-0-470-97389-9 3. Shrof Gautam, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications, Cambridge University Press, ISBN: 9780511778476
References: 1. Dr. Saurabh Kumar, "Cloud Computing", Wiley Publication, ISBN10: 8126536039 2. Buyya, "Mastering Cloud Computing", Tata McGraw Hill, ISBN-13: 978-1-25-902995-0

MERA 515 D :ELECTIVE III : DATA SCIENCE AND BIG DATA SYSTEMS				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	5 Hrs/Week	5	**In Semester**	50 Marks
			End Semester	50 Marks
Prerequisite	Engineering Mathematics, Numerical Techniques and Optimization Methods			
Course Objective	1. Learn and practice data modelling using the entity relationship and developing database designs. 2. Understand the use of Structured Query Language (SQL) and learn SQL syntax. 3. Apply normalization techniques to normalize the database. 4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.			
Course Outcomes	1. Understand the fundamentals of a database systems. 2. Design and draw ER and EER diagram for the real life problem. 3. Convert conceptual model to relational model and formulate relational algebra queries. 4. Design and querying database using SQL. 5. Analyze and apply concepts of normalization to relational database design. 6. Understand the concept of transaction, concurrency and recovery.			
UNIT-I INTRODUCTION TO DATA SCIENCE : Data wrangling, cleaning, and sampling to get a suitable data set - Mathematics for understanding the data – Descriptive statistics : Visualizing Data - Central Tendency –Variability –Standardizing -Normal distribution Sampling Distributions.				
UNIT-II DATA MANIPULATION AT SCALE: Parallel databases, parallel query processing, in-database analytics, MapReduce, Hadoop, Key-value stores and NoSQL; tradeoffs of SQL and NoSQL.				
UNIT-III DATA ANALYTICS USING STATISTICAL TECHNIQUES : Review of univariate regression, multiple regression - Linear regression and related methods - splines and regularization - Kernel methods - Generalized additive models - Kernel smoothing - Gaussian mixtures and EM algorithm - Geometry, subspaces, orthogonality, projections, normal equations, rank deficiency, estimable functions and Gauss-Markov theorem - Computation via QR decomposition, Gramm-Schmidt orthogonalization and the SVD - Multivariate normal distribution				
UNIT-IV COMMUNICATING RESULTS: Visualization - descriptive statistics and visualization, privacy, ethics – multivariate visualization.				
UNIT-V SPECIAL TOPICS: Graph Analytics: structure, traversals, analytics, PageRank, community detection, recursive queries, Semantic web.				
UNIT-VI CASE STUDY: Community Detection, Collaborative Network, Opinion mining, Co-citation network				
TEXT BOOK: 1. Anand Rajaraman, Mining of Massive Datasets‖, Cambridge University Press, 2011. 2. Ravi Kannan and John Hopcroft, Foundations of Data Science‖, 2013.				
REFERENCES: 1. LedolteJohannes , Data Mining and Business Analytics with R‘, John Wiley & Sons, 2013 2. Gareth James and Witten Daniel, Trevor Hastie, Tibshirani Robert, An Introduction to Statistical				

Learning with Applications in R‖, Springer, 2013.
3. Longnecker Michael T., Ott R. Lyman,‖ An Introduction to Statistical Methods and Data Analysis‖, Cengage Learning 2008.
4. Hastie T., Tibshirani R., and Friedman J., The elements of statistical learning: data mining, inference, and prediction‖, Springer, 2009.

MERA 516: MINI PROJECT WITH SEMINAR - I				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	04 Hrs/Week	4	**TW** **OR/PRE**	50 Marks 50 Marks
Course Objective	1. To identify the domain of research 2. To learn to communicate in a scientific language through collaboration with a guide. 3. To categorize the research material confined to the domain of choice 4. To work in professional environment			
Course Outcomes	Course Outcomes: On completion of the course, learner will be able to– CO1: Conduct thorough literature survey confined to the domain of choice CO2: Develop presentation skills to deliver the technical contents CO3: Furnish the report of the technical research domain CO4: Analyze the findings and work of various authors confined to the chosen domain			

Conduction guidelines

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

MERA 517 :DISSERTATION STAGE I				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	8 Hrs/Week	8	**TW** **OR/PRE**	50 Marks 50 Marks
Course Objective	1. To identify the domain of research 2. To learn to communicate in a scientific language through collaboration with a guide. 3. To understand the various means of technical publications and terminologies associated with publications 4. To categorize the research material confined to the domain of choice 5. To formulate research problems with the help of the guide/mentor elaborating the research. 6. To acquire information independently and assess its relevance for answering the research question			
Course Outcomes	On completion of the course, learner will be able to– CO1: Conduct thorough literature survey confined to the domain of choice CO2: Develop presentation skills to deliver the technical contents CO3: Furnish the report of the technical research domain CO4: Analyze the findings and work of various authors confined to the chosen domain			

Dissertation Stage–I is an integral part of the Dissertation work. In this, the student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart,) and Layout & Design of the Set-up. The student is expected to complete the dissertation at least up to the design phase.

As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the duly approved and certified progress report of Dissertation Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute. The examiner will be assessed by a panel of examiners of which one is necessarily an external examiner.

The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report.

The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.

The student has to exhibit the continuous progress through regular reporting and presentations and

proper documentation of the frequency of the activities at the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines circulated / as in the dissertation workbook approved by the Board of Studies. Follow guidelines and formats as mentioned in Dissertation Workbook

MERA 518: INDUSTRY INTERNSHIP / IN HOUSE RESEARCH PROJECT-				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	04 Hrs/Week	4	**TW**	50 Marks
			OR/PRE	50 Marks
Course Objective	1. To identify the domain of research 2. To learn to communicate in a scientific language through collaboration with a guide. 3. To categorize the research material confined to the domain of choice			
Course Outcomes	On completion of the course, learner will be able to– CO1: Conduct thorough literature survey confined to the domain of choice CO2: Develop presentation skills to deliver the technical contents CO3: Furnish the report of the technical research domain CO4: Analyze the findings and work of various authors confined to the chosen domain			

Conduction guidelines:

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

MERA 519: DISSERTATION STAGE II				
Teaching Scheme		**Credits**	**Examination Scheme**	
Theory	20 Hrs/Week	8	**TW** **OR/PRE**	150 Marks 50 Marks
Course Objective	1. To follow SDLC meticulously and meet the objectives of proposed work 2. To test rigorously before deployment of system 3. To validate the work undertaken 4. To consolidate the work as furnished report			
Course Outcomes	On completion of the course, learner will be able to– CO1: Show evidence of independent investigation CO2: Critically analyze the results and their interpretation; infer findings CO3: Report and present the original results in an orderly way and placing the open questions in the right perspective. CO4: Link techniques and results from literature as well as actual research and future research lines with the research. CO5: Appreciate practical implications and constraints of the specialist subject			

Guidelines:

In Dissertation Work Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of Selection of Technology, Installations, UML implementations, testing, Results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions.

The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.

The student has to exhibit continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress needs to be documented unambiguously. It is recommended to continue with guidelines and formats as mentioned in the Dissertation Workbook approved by the Board of Studies.