Minor Program (Machine Learning and Data Science)

Course Code: 05 M01	Fundamental of Python	Credit: 3-0-0: 3

Pre-requisites: NA

Course Outcome

- **Illustrate the syntax and semantics and looping structures in Python programming language**
- **Utilise string handling mechanisms for data handling**
- **Make use of lists, tuples and dictionaries in Python programming language**
- **Develop applications using file handling mechanisms, modules and packages of python language**

Course Contents

Unit I: Introduction to basic Terminologies

Introduction to computers – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages –Developing a program. Algorithms – Characteristics – Flowcharts

Unit II: Python Decision making and Loops:

Data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments; understanding error messages; Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation

Unit III: Python Functions and Modules

Strings and text files; manipulating files and directories, OS and SYS modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers

Unit IV: Python File Operations

Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

Unit V:

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments- Program structure and design- Recursive functions – Introduction to classes and OOP. Applications: Sample problems in engineering, data pre-processing, and plotting tools.

Text Books

1. Introduction to Computation and Programming Using Python, John V Guttag, PHI.
2. Fundamentals of Python – First Programs, Kenneth A. Lambert.Pai, Prentice Hall of India, 2007.
3. Python Programming using Problem Solving Approach, Reema Thareja, Oxford University Press, 2nd Edition, 2023
4. Introduction to Computation and Programming Using Python, John V Guttag, MIT Press Revised and expanded Edition, 2013

Reference book

- Python Programming Fundamentals- A Beginner's Handbook, Nischay kumar Hegde.

Course Code: 05 M01	Fundamental of Python Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

- **Demonstrate a solid understanding of Python syntax and basic programming concepts.**
- **Write Python programs to perform array manipulation operations such as sorting, searching, and filtering.**
- **Apply Python programming techniques to solve engineering problems involving arrays and data structures.**

Course Contents

1. Programs using Control structures (loops, conditionals),
2. Arrays and Lists in Python,
3. Creating and manipulating arrays/lists, Array slicing and indexing, Array operations (concatenation, repetition), Array Manipulation Techniques
4. Multi-dimensional Arrays, Introduction to multi-dimensional arrays, Manipulating multi-dimensional arrays
5. Linear search and binary search algorithms
6. Sorting algorithms (selection sort, bubble sort, merge sort), Algorithm analysis and complexity,
7. Data analysis and visualization.

Course Code: 05 M02	Fundamental of Data Science	Credit: 3-0-0: 3

Pre-requisites: NA

Course Outcome

1. **Understanding concepts of Data science**
2. **Application of Data science in solving real life problem**

Course Contents

Unit I

Introduction to Data Science, Data Science vs Machine Learning, Basics of Statistics, Descriptive statistics: mean, median, mode, variance, standard deviation, Data types: structured, unstructured, and semi-structured, Central Tendency and Dispersion, Application of Data Science

Unit II

Introduction to Probability, Introduction to Probability, Probability Distributions, Probability Distributions, Sampling and Sampling Distribution, Distribution of Sample Means, population, and variance, Confidence interval estimation

Unit III

Hypothesis Testing, Errors in Hypothesis Testing, Hypothesis Testing, ANOVA, Post Hoc Analysis (Tukey's test), Randomize block design (RBD), Two Way ANOVA

Unit IV

Linear Regression, Estimation, Prediction of Regression Model Residual, Multiple Regression Model, Categorical variable regression, Maximum Likelihood Estimation, Logistic Regression, Linear Regression Model Vs Logistic Regression Model, Confusion matrix and ROC, Performance of Logistic Model, Regression Analysis Model Building, Chi - Square Test of Independence, Chi-Square Goodness of Fit Test

Unit V

Introduction to Visualization Tools, Python libraries: Matplotlib, Seaborn, Plotly, Creating Basic Plots

Line plots, bar charts, histograms, scatter plots, Advanced Visualizations: Heatmaps, pair plots, box plots; Visualization Best Practices.

Text Books

1. Doing Data Science: Straight Talk from the Frontline , C. O'Neil and R. Schutt, O'Reilly, 2014.
2. Mining of Massive Datasets, V 2.1, J. Leskovec, A. Rajaraman, and J. D. Ullman, Cambridge University Press, 2014.

Reference book

1. Python Data Science Handbook, Jake Vanderplas, O'Reilly, 2016

Course Code: 05 M02	Fundamental of Data Science Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

· **Design and implementation of Data Science to solve real-world problems.**

List of Experiments:

1. Implementation of ANOVA
2. Implementation Linear Regression and Logistic Regression Model
3. Computation of Performance Measures
4. Implementation 0f Chi - Square Test of Independence
5. Visualization Tools, Python libraries: Matplotlib, Seaborn, Plotly,
6. Creating Basic Plots: Line plots, bar charts, histograms, scatter plots, Advanced Visualizations: Heatmaps, pair plots, box plots

Course Code: 05 M03	Machine Learning	Credit: 3-0-0: 3

Pre-requisites: Fundamental of Data Science – 05 M02

Course Outcome

· Understanding of Machine Learning Concepts

· Application Machine Learning techniques to real life problem

Course Contents

Unit I

Introduction to machine learning, different forms of learning, Data Objects and Attribute Types, Cross Validation, Recent applications of machine learning, such as robotic control, autonomous navigation, speech recognition, image classification.

Unit II

Linear and Non-linear Models, under fitting, overfitting, Hyperparameter and validation sets, Performance Evaluation Measures for Classification Models, Bias/Variance Tradeoff, Loss-function, Classes of estimation, Learning theory, VC theory.

Unit III

Supervised and Unsupervised learning, Dimension Selection and Reduction Techniques, Classification Methods: Linear Discriminant Analysis, Logistic regression, Support Vector Machines, Decision Tree, Naive Bayes, Multilayer Perceptrons and Back Propagation, Lazy Learners, Ensemble Learning

Unit IV

Clustering: Partitional Clustering - k-means, k-medoids; Hierarchical Clustering - Agglomerative, Divisive, Distance measures; Density based clustering.

Unit V

Back-propagation as Feature mapping, Convolutional Neural Networks and Deep Learning.

Course Code: 05 M03	Machine Learning Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

· Design and implementation of Machine Learning algorithms to solve real-world problems.

List of Experiments:

1. Implementation of Linear Discriminant Analysis
2. Implementation of Logistic regression,
3. Implementation of Support Vector Machines,
4. Implementation of Decision Tree,
5. Implementation of Naive Bayes,
6. Implementation of Multilayer Perceptron and Back Propagation
7. Implementation of clustering
8. Performance analysis and comparison of various Machine algorithms on real world problems

Course Code: 05 M04	Data Mining and Data Warehousing	Credit: 3-0-0: 3

Pre-requisites: Fundamental of Data Science – 05 M02

Course Outcome

- **Understand stages in building a Data Warehouse.**
- **Apply pre-processing techniques for data cleansing.**
- **Analyse multi-dimensional modelling techniques.**
- **Analyse and evaluate performance of algorithms for Association Rules.**
- **Applying Data Mining techniques to real life problem.**

Course Contents:

Unit I

Data Warehousing and Business Analysis: - Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

Unit II

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction.

Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis

Unit III

Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Unit IV

Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

Unit V

Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Text Books:

1. Jiawei Han and M Kamber , Data Mining Concepts and Techniques, Second Edition, Elsevier, Publication, 2011.

Reference book

1. Arun K. Pujari, Data Mining Techniques, University Press, 2001
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. Paulraj Ponniah, Data Warehousing: Fundamentals for IT Professionals, Wiley Pb. Linux", Packt, Publishing, 1st Edition, 2017.

Course Code: 05 M05	Social Media Analytics	Credit: 3-0-0: 3

Pre-requisites: Machine Learning – 05 M03

Course Objectives:

- **Understand the importance of social media and networks.**
- **Enhance analytical skills for analyzing social media and networking data.**
- **Develop skills to leverage extended enterprise data.**
- **Create real-life case studies using social media data**

Course Contents

Unit I Introduction to social network analysis:

Vertex or node, edge, neighbors, degree, shortest path, cycle, tree, complete graph, bipartite graphs, directed graphs, weighted graphs, adjacency matrix; Social networks examples (facebook, movie collaboration, and paper collaboration), information networks (web), biological networks (neural networks, ecological networks), random graphs with general degree distributions, models of network formation, Properties of Large-Scale Networks: Six-degree separation, scale-free distributions, small-world effect, and strong community structure;

Unit II

Networks and Centrality Measures: Degree, closeness, betweenness, edge betweenness, eccentricity, clustering coefficient, eigenvector; Spread of influence through a network, influence maximization in networks, spread of disease on networks, Information networks; Community Detection and graph based clustering: communities in social media, node-centric community detection, group-centric community detection, network-centric community detection, hierarchy-centric community detection, Topology discovery. Community Evaluation;

Unit III Link Prediction: Challenges in link prediction, link prediction methods and algorithms, clustering approaches for link prediction;

Unit IV Sentiment Analysis:

Sentiments and Opinions, lexicon based methods, machine learning based methods, feature-based sentiment analysis, slang sentiment analysis;

Unit V

Social Listening and Social Recommendation Systems: Social Recommendation Using collaborative filtering, community detection and probabilistic matrix factorization.

Text Books

1. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining – An Introduction, Cambridge University Press, 2014.
2. Charu C Aggarwal (Ed.), Socail Network Data Analytics, Springer, 2011.

Minor Program (Robotics & Automation)

Course Code: 05 M01	Mechatronics	Credit: 3-0-0: 3

Pre-requisites: NA

Course Outcomes

- **To provide the student with the knowledge of sensors, transducers, various types of actuators used in mechatronics systems and also the use of PLCs and mechatronics design.**

Course Contents

UNIT I INTRODUCTION:

Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems - Control Systems.

UNIT II

SENSORS AND TRANSDUCERS: Introduction - Performance Terminology – Potentiometers - LVDT - Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor - Temperature sensors - Light sensors - Selection of sensors - Signal processing.

UNIT III ACTUATORS:

Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magneto strictive - Shape memory alloy - applications - selection of actuators.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS

Introduction - Basic structure - Input and output processing - Programming - Mnemonics-Timers, counters and internal relays - Data handling - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS CASE STUDIES:

Steps in mechatronics design - Possible design solutions-Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine – Mechatronics Control in automated Manufacturing – Data Acquisition - Case studies

Textbooks:

1. Bolton, W., “Mechatronics”, Pearson education, second edition, fifth Indian Reprint, 2003

2. Bradley, D.A., Dawson. D., Buru, N.C. and Loader, A.J., “Mechatronics” Nelson Thornes Ltd, Eswar press, Indian print, 2004.
3. Histand, M.B. and Alciatore,D.G., “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 1999.
4. Mahalik,N.P., “Mechatronics Principles, Concepts and applicatlions” Tata McGraw-Hill Publishing Company Limited, 2003.

Reference Books:

1. Onwubolu, G.C., "Mechatronics Principles and Applications", Elsevier, 2006.
2. Shetty, D. and Kolk, O. A., “Mechatronics systems design”, PWS Publishing company, 2007.
3. Sinclair, I., “Sensors and Transducers”, Elsevier, Newnes, Reprint 2012. 8. Smaili, .A. and Mrad, F., "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.

Course Code: 05 M01	Mechatronics Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

Course Contents

Course Code: 05 M02	Industrial Automation & Robotics	Credit: 3-0-0: 3

Pre-requisites: NA

Course Objectives:

- To understand the basic components of robots.
- To study and differentiate types of robots and robot grippers.
- To analyze forces in links and joints of a robot.
- To study robot programming a robot to perform tasks in industrial applications.

Course Contents

UNIT 1 AUTOMATION:

Introduction to Automation of different manufacturing processes. Levels of automation, types of automation system, transducers, Microprocessor based controllers and its application, Programmable Logic Circuit. Typers of sensor and transducer. Hydraulics & Pneumatic Systems.

UNIT 2 INTRODUCTION AND ROBOT KINEMATICS

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT 3 ROBOT DRIVES AND CONTROL

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT 4 ROBOT SENSORS Transducers and Sensors –

Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT 5 ROBOT PROGRAMMING

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation; Problem reduction and solution techniques - Application of AI and KBES in Robots

Text Books:

1. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 1986.
3. Jordanides,T. and Torby,B.J., ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.

Course Code: 05 M01	Industrial Automation & Robotics Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

Course Contents

Course Code: 05 M03	Advanced CAD	Credit: 3-0-0: 3

Pre-requisites: NA

Course Objectives:

- **To provide an overview of how computers can be utilized in mechanical component.**
- **To understand different types of curves in geometric modelling.**
- **To study the fundamentals of solid modelling.**

Course Contents

UNIT 1 Fundamentals of Computer Graphics

Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation.

UNIT II Geometric Modelling-

straight line, representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves

UNIT III

Techniques of surface modelling, plane surface, cylindrical surface, surface of revolution, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces

UNIT IV

Fundamental of solid design, parametric space of a solid, surface and curves in a solid, Solid modelling techniques, CSG and B-rep. Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation. Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

Text Books:

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw

Course Code: 05 M03	Advanced CAD Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

1. To provide an experimental foundation for the theoretical concepts introduced
2. To achieve hands-on experimental skills and the study of practical applications will bring more confidence.

List of Experiments/Activities

1. Introduction and working on sketcher and part design workbench in CATIA V5
2. Working with advanced modeling tools (Sweep, Blend, pattern, mirror & Swept Blend)
3. Working on complex Assembly workbench (CATIA)
4. Working with DMU kinematics module of CATIA V5
5. Generating, editing and modifying drawings in Drafting workbench CATIA V5

Minor project on modelling of a complex design.

Course Code: 05 M04	Additive Manufacturing	Credit: 3-0-0: 3

Pre-requisites: NA

Course Objectives:

- **To comprehend basic difference between subtractive and additive manufacturing (AM).**
- **To prepares students for learning various rapid prototyping processes.**
- **To study different post processing techniques, and data preparations for AM.**
- **To understand the basic foundation for understanding the emerging areas of AM and their applications.**

Course Contents

UNIT1 Introduction to Additive Manufacturing:

Introduction to Additive Manufacturing (AM), AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Classification of AM processes.

UNIT II Liquid Based Rapid Prototyping Processes:

Photo polymerization, principle and working of stereo lithography apparatus, scanning techniques, curing processes, Mask Projection based RP systems, Two Photon Vat Photopolymerization, Typical materials and applications.

UNIT III Powder Based Rapid Prototyping Processes:

Powder fusion mechanism, powder handling and recycling, Principle and working of Selective Laser Sintering, Laser Engineering Net Shaping process, Electron Beam Melting, Binder Jet 3D Printing, process parameters, Typical materials and applications.

UNIT IV Solid Based Rapid Prototyping Processes:

Basic principle and working of fused deposition modelling process, liquification, solidification and bonding, bio extrusion, Laminated Object Manufacturing process, Wire and Arc based RP system, Typical materials and applications. Data Preparation, Post Processing and Application for AM Future Directions of AM: Introduction, new types of products and employment and entrepreneurship.

Text Books:

1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles & Applications”, World Scientific, 2003.
2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010
3. Ali K. Kamrani, Emand Abouel Nasr, “Rapid Prototyping: Theory & Practice”, Springer, 2006.
4. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001

Course Code: 05 M05	Automation in Manufacturing	Credit: 3-0-0: 3

Pre-requisites: NA

Course Objectives:

- **To comprehend the basic concepts of automation and smart manufacturing**
- **To prepares students for learning different types of automation systems, actuation systems, sensor and transducers.**
- **To understand the hydraulic and pneumatic systems in manufacturing.**
- **To study the basic foundation for understanding the necessity of automation**

Course Contents

UNIT I Automation:

Introduction to Automation of different manufacturing processes. Levels of automation, types of automation system, transducers, Microprocessor based controllers and its application, Programmable Logic Circuit.

UNIT II Sensors & Transducers:

Classification, Performance terminologies, Displacement, Position & proximity sensors, Photo detectors, Optical encoders, Pneumatic sensor, Hall effect sensor, Velocity & motion sensors: Incremental encoder, Tachogenerator, Piezo electric sensors, Tactile sensors, Flow & temperature sensors: Ultrasonic sensor, Light sensors, Selection of sensors, Interference & noise in measurement.

UNIT III

Hydraulics & Pneumatic Systems design and their application to manufacturing equipment; Sequence operation of hydraulic and pneumatic cylinders and motors.

UNIT IV

Electro Pneumatic & Electro Hydraulic Systems design, Relay Logic circuits, Feedback control systems, PID Controller; Drives and mechanisms of an automated system: stepper motors, servo drives. PLC, Ladder Logic circuit. Intro to industry 4.0. Lean Production Systems, Smart factories, Cyber Physical Systems.

Text Books:

1. M. P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson, 2015.

2. Esposito A., Fluid Power with Applications, Pearson Prentice Hall, 6 th Edition, 2012.

3. W. Bolton, “Mechatronics”, Pearson Education (India), 2003.

4. Shetty D., Kolk R. A., “Mechatronic System Design”, PWS Publicity Boston, 2002.

5. Zongwei Luo, Smart Manufacturing Innovation and Transformation: Interconnection and Intelligence, Business Science Reference (an imprint of IGI Global), 2014.

Minor Program (Integrated Chip Design)

Course Code: 05 M01	Digital Electronics	Credit: 3-0-0: 3

Pre-requisites: NA

Course Objectives

- To teach various number systems, binary codes and their applications
- To familiarize the students the importance of error detection and error correction codes.
- To inculcate concepts of K-MAP to simplify a Boolean expression
- To facilitate students in designing a logic circuit.

Course Contents

UNIT I DIGITAL SYSTEMS AND BINARY NUMBERS:

Digital systems, binary numbers, number base conversions, octal and hexadecimal numbers, complements, signed binary numbers, binary codes, error detection and error correction codes.

BOOLEAN ALGEBRA AND LOGIC GATES: Basic definitions, axiomatic definition of Boolean algebra, basic theorems and properties of Boolean algebra, Boolean functions, canonical and standard forms, other logic operations, digital logic gates.

UNIT II GATE LEVEL MINIMIZATION:

The k-map method, four-variable map, five-variable map, product of sums simplification, don't-care conditions, NAND and NOR implementation, determination and selection of Prime Implicants, Essential and Non-essential prime Implicants.

UNIT III COMBINATIONAL CIRCUITS:

Design procedure, Binary Adder, Binary Subtractor, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers, and Demultiplexers.

UNIT IV SEQUENTIAL CIRCUITS:

SYNCHRONOUS SEQUENTIAL LOGIC: Sequential circuits, latches, flip-flops, analysis of clocked sequential circuits, State reduction and assignment, design procedure. REGISTERS AND COUNTERS: Registers, shift registers, ripple counters, synchronous counters, counters with unused states, ring counter, Johnson counter.

UNIT V MEMORY AND PROGRAMMABLE LOGIC:

Introduction, Random access memory, memory decoding, error detection and correction, read only memory, programmable logic array, programmable array logic, sequential programmable devices.

UNIT VI ADVANCED CONCEPTS:

Advanced Verilog Concepts - Synthesis concepts - Inferring latches and flip-flops - Modelling techniques for efficient circuit design - Design of high-speed arithmetic circuits - Parallelism Pipelined Wallace tree tipliers - Systolic algorithms - Systolic matrix multiplication.

Textbooks:

1. Morris Mano, and Michael D. Ciletti, “Digital Design”, Fifth Edition, PHI, 2012.
2. Roth (2004), Fundamentals of Logic Design, 5th Edition, Thomson, India.

Reference Books:

1. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL”, Second Edition, Pearson Education, 2010.
2. Stephen Brown, “Fundamentals of Digital Logic with Verilog”, McGraw Hill, 2007.

Course Code: 05 M01	Digital Electronics Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Objectives:

- To provide an experimental foundation for the theoretical concepts introduced
- To achieve hands-on experimental skills and the study of practical applications will bring more confidence.

List pf experiments

1. Verification of truth tables of the following Logic gates Two input (i) OR (ii) AND (iii) NOR (iv) NAND (v) Exclusive-OR (vi) Exclusive-NOR
2. Design a simple combinational circuit with four variables and obtain minimal expression and verify the truth table using Digital Trainer Kit.
3. Verification of functional table of 3 to 8-line Decoder /De-multiplexer.
4. 4variable logic function verification using 8 to1 multiplexer.
5. Design full adder circuit and verify its functional table.
6. Verification of functional tables of (i) JK Edge triggered Flip–Flop (ii) JK Master Slav Flip–Flop (iii) D Flip-Flop
7. Design a four-bit ring counter using D Flip–Flops/JK Flip Flop and verify output
8. Design a four bit Johnson's counter using D Flip-Flops/JK Flip Flops and verify output
9. Verify the operation of 4-bit Universal Shift Register for different Modes of operation.
10. Draw the circuit diagram of MOD-8 ripple counter and construct a circuit using T-Flip-Flops and Test It with a low frequency clock and sketch the output waveforms.
11. Design MOD–8 synchronous counter using T Flip-Flop and verify the result and sketch the output waveforms.
12. (a) Draw the circuit diagram of a single bit comparator and test the output (b) Construct 7 Segment Display Circuit Using Decoder and7 Segment LED and test it.

Course Code: 05 M02	Microprocessor	Credit: 3-0-0: 3

Pre-requisites: NA

Course Outcomes

- To understand the concepts of Architecture of 8086 microprocessor
- To understand the design aspects of I/O and Memory Interfacing circuits
- To understand the architecture and programming of ARM processor

Course Contents

UNIT I: THE 8086 MICROPROCESSOR -
Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT II: 8086 SYSTEM BUS STRUCTURE –
8086 signals – Basic configurations – System bus timing –System design using 8086 – IO programming – Introduction to Multiprogramming – System Bus Structure - Multiprocessor configurations – Coprocessor, closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III MICROCONTROLLER -
Architecture of 8051 – Special Function Registers (SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Programming 8051 Timers – Interfacing Microcontroller - Serial Port Programming - Interrupts Programming – LCD & Keyboard - External Memory Interface- Stepper Motor.

UNIT IV INTRODUCTION TO EMBEDDED SYSTEMS
Complex systems and microprocessors– Embedded system design process – Instruction sets preliminaries - ARM Processor – CPU: programming input and output supervisor mode, exceptions and traps – Co-processors- Memory system mechanisms – CPU performance

Text Books:

1. Yu-Cheng Liu, Glenn A.Gibson, “Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design”, Second Edition, Prentice Hall of India, 2007
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, 2 nd Edition, Pearson Education, 2011
3. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, 3rd Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2012

Reference book:

1. Doughlas V. Hall, "Microprocessors and Interfacing, Programming and Hardware", Tata McGraw-Hill, 2012
2. Jonathan W. Valvano, "Embedded Microcomputer Systems Real Time Interfacing", 3 rd Edition, Cengage Learning, 2012

Course Code: 05 M02	Microprocessor Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

· **Design and implementation of solve real-world problems.**

List of Experiments:

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers.
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
3. To perform multiplication and division of two 8 bit numbers using 8085.
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program to arrange an array of data in ascending and descending order.
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8085 instruction set.
7. To write a program to initiate 8251 and to check the transmission and reception of character.
8. To interface 8253 programmable interval timer to 8085 and verify the operation of 8253 in six different modes.

Course Code: 05 M03	Semiconductor devices and Circuits	Credit: 3-0-0: 3

Pre-requisites: Engineering Physics – BSC02

Course Outcome

- Understand the fundamental principles of semiconductor materials and devices
- Analyze and design basic diode and transistor circuits.
- Gain hands-on experience with practical applications of semiconductor devices.
- Understand the operation and application of FETs and BJTs in electronic circuits.

Course Contents

Unit I Semiconductor Materials and Physics

Introduction to Semiconductors: Classification of materials (conductors, insulators, semiconductors). **Energy Bands in Solids**: Concept of energy bands, Fermi level, bandgap. **Intrinsic and Extrinsic Semiconductors**: Intrinsic carrier concentration, doping, types of extrinsic semiconductors (n-type and p-type). **Carrier Transport**: Drift, diffusion, and mobility. **Semiconductor Equations**: Continuity equation, carrier generation and recombination.

Unit II Diodes and Their Applications

PN Junction Diode: Construction, operation, and I-V characteristics; **Diode Models**: Ideal diode, piecewise linear model, small signal model; **Diode Applications**: Rectifiers, Zener diodes, Schottky diodes, LED, Photodiode, and their applications.; **Biasing of Diodes**: Forward and reverse bias, diode equation, reverse breakdown; **Clipping and Clamping Circuits**: Applications in signal processing.

Unit III Bipolar Junction Transistors (BJTs)

Introduction to BJTs: Construction, working principle, and I-V characteristics; **BJT Operation**: Active, cutoff, and saturation regions; **Transistor Models**: Small-signal model, hybrid pi model; **Biasing of BJTs**: Fixed bias, voltage divider bias, thermal stability; **Transistor Applications**: Amplifiers, switches, and oscillators.

Unit IV Field Effect Transistors (FETs)

Introduction to FETs: Construction and working principle of JFET and MOSFET; **Characteristics of FETs**: Transfer characteristics, input/output characteristics of JFET and MOSFE; **Biasing of FETs**: Biasing techniques for JFET and MOSFET; **MOSFET Variants**: Enhancement-mode and depletion-mode MOSFETs; **FET Applications**: Amplifiers, analog switches, digital circuits..

Unit V Semiconductor Devices in Circuits

Amplifiers: Transistor amplifier circuits (Common-emitter, Common-collector, Common-base for BJTs); **Oscillators**: RC, LC, and crystal oscillators using semiconductor devices; **Voltage Regulators**: Zener diode voltage regulation, linear regulators, and switching regulators; **Power Semiconductor Devices**: Diodes, transistors, and thyristors in power electronics; **Applications**: Semiconductor devices in digital and analog circuits, switching circuits, and signal processing.

Text Books:

1. **"Semiconductor Devices: Physics and Technology"** by S. M. Sze
2. **"Electronic Devices and Circuits"** by David A. Bell
3. **"Microelectronic Circuits"** by Sedra and Smit

Course Code: 05 M03	**Semiconductor devices and Circuits Laboratory**	**Credit: 0-0-2: 1**

Pre-requisites: NA

Course Outcomes

· Design and implementation of basics devices of semiconductor.

List of Experiments:

1. V-I Characteristics of a PN Junction Diode
2. Zener Diode Characteristics
3. Half-Wave and Full-Wave Rectifiers
4. Transistor Characteristics (Common-Emitter Configuration)
5. Biasing of a BJT (Fixed Bias)
6. Transfer Characteristics of a MOSFET
7. Input and Output Characteristics of a JFET
8. RC Phase Shift Oscillator using Transistor

Course Code: 05 M04	Digital Instrumentation	Credit: 3-0-0: 3

Pre-requisites: Microprocessor - 05 M02

Course Outcome

- **Understand the principles and components of digital instrumentation systems, including sensors, signal conditioning, and data acquisition.**
- **Apply digital measurement techniques and embedded system concepts to design and implement reliable instrumentation solutions.**
- **Analyze and integrate advanced technologies such as IoT and AI to enhance the performance and functionality of digital instrumentation systems.**

Course Contents:

Unit I Fundamentals of Digital Instrumentation Systems
I**ntroduction to Instrumentation**: Measurement systems, static and dynamic *characteristics*; **Digital vs. Analog Systems**: Benefits, limitations, and use cases in electronics and computing.; **System Components**: Sensors, actuators, ADC/DAC, and signal conditioning; **Real-World Applications**: Industrial, medical, and computing instrumentation systems.

Unit II Digital Measurement Techniques and Signal Processing
Digital Measurement Methods: Voltage, current, frequency, and phase measurement; **Sampling Theory**: Nyquist rate, aliasing, and quantization; **Digital Signal Conditioning**: Filtering, multiplexing, and demultiplexing; **Error Detection and Correction**: Techniques for reliability in digital instrumentation.

Unit III Embedded Systems in Instrumentation
Introduction to Embedded Systems: Architecture and components (microcontrollers, microprocessors); **Interfacing Sensors and Actuators**: Digital and analog interfacing techniques; **Programming Embedded Systems**: Basics of C/Python programming for microcontrollers; **Real-Time Systems**: Concepts and examples in industrial and computing applications.

Unit IV Communication in Digital Instrumentation Systems
Wired Communication Protocols: UART, SPI, and I2C; **Wireless Communication Technologies**: Bluetooth, Wi-Fi, ZigBee, and LoRa; **Networking in Instrumentation**: IoT protocols (MQTT, HTTP) for smart instrumentation; **Data Acquisition and Transmission**: Techniques for real-time data sharing and analysis.

Text Books:

1. **"Modern Electronic Instrumentation and Measurement Techniques,** Albert D. Helfrick and William D. Cooper; Publisher: Pearson Education.
2. **"Digital Instrumentation"**, A.J. Bowyer, IET Publications

Reference book

1. **"Measurement Systems: Application and Design",** Ernest O. Doebelin and Dhanesh N. Manik, McGraw Hill Education.
2. **"Principles of Measurement Systems",** John P. Bentley, Pearson Education

Course Code: 05 M05	Embedded System Design	Credit: 3-0-0: 3

Pre-requisites: Digital Instrumentation – 05 M04

Course Objectives:

- **The issues relating to hardware and software design concepts associated with processor in Embedded Systems.**
- **The concept of low power microcontrollers.**
- **The hardware software co- design issues pertaining to design of an Embedded System using low power microcontrollers.**

Course Contents

Unit I Introduction to Embedded Electronic Systems and Microcontrollers:

An Embedded System-Definition, Embedded System Design and Development Life Cycle, An Introduction to Embedded system Architecture, The Embedded Systems Model, Embedded Hardware: The Embedded Board and the von Neumann Model, Embedded Processors: ISA Architecture Models, Internal Processor Design, Processor Performance, Board Memory: Read-Only Memory (ROM), Random-Access Memory (RAM), Auxiliary Memory, Memory Management of External Memory and Performance, Approaches to Embedded Systems, Small Microcontrollers, Anatomy of a Typical Small Microcontroller, Small Microcontrollers Memory, Embedded Software, Introduction to small microcontroller (MSP430).

Unit II

Architecture of the MSP430 Processor: Central Processing Unit, Addressing Modes, Constant Generator and Emulated Instructions, Instruction Set, Examples, Reflections on the CPU and Instruction Set, Resets, Clock System, Memory and Memory Organization. Functions, Interrupts, and Low-Power Mode: Functions and Subroutines, Storage for Local Variables, Passing Parameters to a Subroutine and Returning a Result, Mixing C and Assembly Language, Interrupts, Interrupt Service Routines, Issues Associated with Interrupts, Low-Power Modes of Operation.

Unit III

Digital Input, Output, and Displays: Parallel Ports, Digital Inputs, Switch Debounce, Digital Outputs, Interface between Systems, Driving Heavier Loads, Liquid Crystal Displays, Simple Applications of the LCD. Timers: Watchdog Timer, Timer_A, Timer_A Modes, Timer_B,Timer_B Modes, Setting the Real-Time Clock, State Machines.

Unit IV Sentiment Analysis:

Communication Peripherals in the MSP430, Serial Peripheral Interface, SPI with the USI, SPI with the USCI, A Thermometer Using SPI Modes, Inter-integrated Circuit Bus(I^2C) and its operations, State Machines for I^2C Communication, A Thermometer Using I^2C, Asynchronous Serial Communication, Asynchronous Communication with the USCI_A, A Software UART Using Timer_A, Other Types of Communication.

Text Books

1. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining – An Introduction, Cambridge University Press, 2014.
2. Charu C Aggarwal (Ed.), Socail Network Data Analytics, Springer, 2011.

Minor Program (IoT & Cyber Physical Systems)

Course Code: 05 M01	Computer Networks	Credit: 3-0-0: 3

Pre-requisites: NA

Course Outcomes

- **To introduce concepts of Cloud and Edge Computing.**

Course Contents

UNIT I Introduction

Network architecture - protocol implementation issues - network design. Reference models- The OSI Reference Model- the TCP/IP Model - A Comparison of the OSI and TCP/IP Models.

Physical Layer: Digital and Analog Signals - Periodic Analog Signals - Transmission Impairments - Digital data transmission techniques - Analog data transmission techniques - Multiplexing and Spread Spectrum.

UNIT II Data Link Layer

Data Link Layer: Error Detection and Correction - Parity - LRC - CRC - Hamming Code - Flow Control and Error Control - Stop and wait - ARQ - Sliding window - HDLC - Multiple Access Protocols - CSMA - CSMA/CD and CSMA/CA - IEEE 802.3 Ethernet.

UNIT III Network Layer

Packet Switching and Datagram approach - IP Addressing methods - Subnetting - Routing - Distance Vector Routing - RIP - Link State Routing - OSPF - BGP - Multicast Routing - MOSPF - DVMRP - Broadcast Routing.

UNIT IV Transport Layer

Elements of transport protocol - Congestion control – The Internet's Transmission Control Protocol (TCP) - Remote Procedure Call (RPC) – Implementation semantics of RPC – BSD sockets - client-server applications.

UNIT V Application Layer

Domain name server – Simple Mail Transfer Protocol – File Transfer Protocol - World wide web - Hypertext transfer protocol -Presentation formatting and data compression-

Introduction to Network security - Web Services architectures for developing new application protocols.

Textbooks:

1. Andrew S. Tanenbaum, David J Wetherall, "*Computer Networks"*, 5th Edition, Pearson Edu, 2010

2. James F. Kuros & Keith W. Ross, “Computer Networking”, 8th Edition, Pearson Education.
3. Behrouz A. Foruzan, “Data Communication and Networking”, Fifth Edition, Science Engineering & Math Publications, 2013

Reference Books:

1. W. Stallings, “Data and Computer Communication”, Tenth Edition, Pearson Education, 2014.

Course Code: 05 M01	Computer Networks Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

- **To create client and server applications using the "Sockets" API and the implementation of Data link layer protocol and TCP layer**
- **To conduct computer communication network simulations**
- **To have a hands-on experience of computer network simulation and modelling techniques using NS-3 simulation software**

Course Contents

1. Exercises using NS-3 Network Simulator

1) **Basics of Network Simulation**
   a) Introduction, Platform required to run network simulator, Backend Environment of Network Simulator, Agents and applications, Tracing
2) **Simulating a Local Area Network**
   a) Local Area Network, LAN Topologies, MAC Protocol, Taking turns, Ethernet, Ethernet Frame Structure, Ethernet Versions, Simulating a LAN using Network Simulator3
   b) Implementation of various MAC protocols
   c) Setting up of various network topologies
   d) Measurement of routing protocols
3) **Measuring Network Performance**
   a) Network Performance Evaluation, Performance Evaluation Metrics, Parameters Affecting the Performance of Networks, Performance Evaluation Techniques, Network Performance Evaluation using NS-3
   b) Setting up of network that carries various application protocols and analyzing the performances

2. Hands on experiments on Network equipment's

a) Switches, Routers
b) Hardware firewall

3. Exercises on Socket Programming using C and Java

Reference Books / Online Resources:

1. W. Richard Stevens, "UNIX Network Programming – Networking APIs: Sockets and XTI", Vol. 1, Second Edition, Prentice Hall, 1998.
2. Eitan Altman, Tania Jimenez, "NS Simulator for Beginners", Morgan & Claypool Publishers, 2011.
3. Jack L. Burbank, "An Introduction to Network Simulator 3", First Edition, Wiley-Blackwell, 2015.

Course Code: 05 M02	Cloud & Edge Computing	Credit: 3-1-0: 4

Pre-requisites: Computer Networks – 05 PEC02

Course Objectives:

- **To gain knowledge about the mathematics of the cryptographic algorithms**
- **To get an insight into the working of different existing cryptographic algorithms**
- **To learn about key exchange protocols and attacks on such protocols**
- **To learn how to use cryptographic algorithms in security**

Course Contents

UNIT I Introduction of Cloud Computing

Introduction to Cloud Computing, Recent Trends in Computing Cloud Computing, Evolution of cloud computing.

UNIT II Cloud Architecture

Cloud Computing Architecture, Service Management in Cloud Computing Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service(SaaS), Data Management in Cloud Computing, Resource Management in Cloud Computing, Cloud Implementation..

UNIT III Cloud Services & Edge Computing

Open Source and Commercial Clouds, Cloud Simulator, Research trend in Cloud Computing, Fog Computing, VM Resource Allocation, Management and Monitoring, Introduction to Edge Computing, the Cloud Computing analytics pipeline, Coordination of Cloud Services.

UNIT IV Introduction of Fog-Edge model

Serverless Computing and FaaS Model, Cloud-Fog-Edge enabled Analytics, Cloud Security, Case Studies and Recent Advancements.

Text Books:

1. Cloud Computing: Principles and Paradigms, Editors: RajkumarBuyya, James Broberg, Andrzej M. Goscinski, Wiley,2011.
2. Enterprise Cloud Computing - Technology, Architecture, Applications, GautamShroff, Cambridge University Press, 2010.

Reference Books:

1. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012.

Course Code: 05 M03	**Internet of Things**	**Credit: 3-0-0: 3**

Pre-requisites: Computer Networks – 05 PEC02

Course Objectives:

- **Identify the components of IoT**
- **Analyze various protocols of IoT**
- **Design portable IoT using appropriate boards**
- **Develop schemes for the applications of IOT in real time scenarios**
- **Design business Intelligence and Information Security for WoT**

Course Contents

UNIT I Introduction

Definition - Foundations - Challenges and Issues - Identification - Security - Components in internet of things: Control Units - Sensors - Communication modules - Power Sources - Communication Technologies - RFID - Bluetooth - Zigbee - Wifi - Rflinks - Mobile Internet - Wired Communication - IoT Platform Overview - Raspberry pi - Arduino boards.

Unit II IoT Protocols

Protocol Standardization for IoT - M2M and WSN Protocols - SCADA and RFID Protocols - Issues with IoT Standardization - Protocols - IEEE 802.15.4 - BACNet Protocol - Zigbee Architecture - Network layer - APS Layer Security.

Unit III Resource Management in the Internet of Things

Clustering - Software Agents - Data Synchronization - Clustering Principles in an Internet of Things Architecture - The Role of Context - Design Guidelines - Software Agents for Object Data Synchronization - Types of Network Architectures - Fundamental Concepts of Agility and Autonomy - Enabling Autonomy and Agility by the Internet of Things - The Evolution from the RFID-based EPC Network to an Agent based Internet of Things - Agents for the Behaviour of Objects.

Unit IV Case Study and IoT Application Development

IoT applications in home infrastructures security Industries - IoT electronic equipment's - Use of Big Data and Visualization in IoT - Industry 4.0 concepts - Sensors and sensor Node - Interfacing using Raspberry Pi/Arduino- Web Enabled Constrained Devices.

Unit V Web of Things

Web of Things versus Internet of Things - Architecture Standardization for WoT - Platform Middleware for WoT - WoT Portals and Business Intelligence - Cloud of Things: Grid/SOA and Cloud Computing - Cloud Standards - Cloud of Things Architecture - Open-Source e-Health sensor platform.

Text Books:

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.

2. Dieter Uckelmann, Mark Harrison, “Architecting the Internet of Things”, Springer, 2011.

Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things (A Hands-On-Approach)”, VPT, 2014.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things – Key Applications and Protocols”, Wiley, 2012.
3. Luigi Atzori, Antonio Lera, Giacomo Morabito, “The Internet of Things: A Survey”, Journal on Networks, Elsevier Publications, October, 2010.

Course Code: 05 M03	Internet of Things Laboratory	Credit: 0-0-2: 1

Pre-requisites: NA

Course Outcomes

1. To provide an experimental foundation for the theoretical concepts introduced
2. To achieve hands-on experimental skills and the study of practical applications will bring more confidence.

Course Contents

1. Controlling the Light Emitting Diode (LED) with a push button.
2. Interfacing the RGB LED with the Arduino.
3. Controlling the LED blink rate with the potentiometer interfacing with Arduino
4. Detection of the light using photo resistor
5. Interfacing of temperature sensor LM35 with Arduino
6. Interfacing Servo Motor with the Arduino
7. Interfacing of the Active Buzzer with Arduino.
8. Interfacing of the Relay with Arduino

Course Code: 05 M04	Foundations of Cyber Physical Systems	Credit: 3-0-0: 3

Pre-requisites: Computer Networks – (05 PEC02), Internet of Things (05 M03)

Course Objectives:

- **To develop the student's ability to understand the concept of cyber physical systems' characteristics, requirements and architecture.**
- **To develop the student's ability to understand the fundamentals of microprocessor and micro-controller families and their architecture with special emphasis on Digital Signal Processors.**
- **To provide the students with some knowledge and analysis skills associated with the principles of memory organisation and bus structure of cyber physical systems.**
- **To develop the student's ability to understand the concepts of cyber physical system software with special emphasis on real time operating system and particularly real time job scheduling.**
- **To provide the students with some basic knowledge of power aware architecture & hardware software co design.**

Course Contents

Unit 1: Fundamentals of - Cyber Physical Systems

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

Unit 2: Platform Components for Cyber Physical Systems

CPS HW platforms - Processors, Sensors, Actuators CPS Network - WirelessHart, CAN, Automotive Ethernet Scheduling Real Time CPS tasks: Table-driven and Event driven schedulers Hybrid schedulers

Unit 3: Principles of Dynamical Systems

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

Unit 4: CPS implementation issues

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

Unit 5: Intelligent CPS

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

Text Books:

1. Suh, Sang C., U. John Tanik, John N. Carbone, and Abdullah Eroglu, eds. Applied cyber-physical systems. Springer New York, 2014.
2. Alur, Rajeev. Principles of cyber-physical systems. MIT Press, 2015.

3. Colombo, Armando W., Thomas Bangemann, Statmatis Karnouskos, Jerker Delsing, Petr Stluka, Robert Harrison, Francois Jammes, and Jose L. Lastra. "Industrial cloud-based cyber-physical systems." The Imc-aesop Approach 22 (2014): 4-5.

Reference Books:

1. Andrew M Sloss, Dominic Symes, Chris Wright, “ARM System Developers Guide: Designing optimizing System Software” (Online resource)

Course Code: 05 M05	Network Security	Credit: 3-0-0: 3

Pre-requisites: Computer Networks – 05 PEC02

Course Objectives:

- **To gain knowledge about the mathematics of the cryptographic algorithms**
- **To get an insight into the working of different existing cryptographic algorithms**
- **To learn about key exchange protocols and attacks on such protocols**
- **To learn how to use cryptographic algorithms in security**

Course Contents

UNIT I Mathematical Foundations

Number theory: Introduction to number theory – Modular Arithmetic; Finite fields; Number theory properties – Primality testing; Fermat's and Euler's theorem; Chinese remainder theorem; Integer factorization; discrete logarithm; Euclid's algorithm for integers - quadratic residues - Legendre symbol - Jacobi symbol.*

UNIT II Introduction to security

Security architecture; security attacks; security services; security mechanisms; different type of attack: CMA - CPA - CCA - Shannon perfect secrecy - OTP - Pseudo random bit generators; CIA Architecture.

UNIT III Classical and Modern Ciphers

Classical and modern ciphers; pseudorandomness; statistical properties of random sequences; discrete probability; Symmetric key and public key cryptosystems; General design principles of block ciphers; substitution-permutation networks; General design principles of stream ciphers; linear feedback shift-register sequences; boolean functions; canonical examples - DES, 3DES, AES, RC4, RC5, RC6, A5/1,2; Analysis methodologies - differential, linear, square, algebraic techniques. Public key cryptosystems Diffie Hellman key exchange, public key encryption, digital signatures, Knapsack, RSA, ElGamal, Rabin schemes.

UNIT IV Message Authentication

Functionalities of entity, content authentication; message digests and hashing schemes; Key management and Distribution-Certificate authorities; PKI; MAC; Hashing; Authentication protocols.

UNIT V Digital Signature & Cryptanalysis

Digital Signature Standard; Cryptographic embedding in different layers of network stack; applications, protocols and standards; social, economic and geo-political; Introduction to Elliptic Curve Cryptosystems, Elliptic Curve Cryptosystems based Digital Signature scheme; Intractable (Hard) Problems.

Text Books:

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", Second Edition, Tata McGraw Hill, 2013.

2. Cryptography: Theory and Practice, Third Edition (Discrete Mathematics and Its Applications) by Douglas R. Stinson, CRC Press.
3. Menezes, P. Van Oorschot, S. Vanstone, "*Handbook of Applied Cryptography*", CRCPress, 2004

Reference Books:

1. William Stallings, "*Cryptography and Network Security*", 6th edition Pearson Education, 2014
2. *[Online Course]* Course on Cryptography by Dan Boneh.