Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(*An Autonomous Institute affiliated to Savitribai Phule Pune University*)

Structure & Syllabus of

Second Year B.Tech.

(Instrumentation and Control Engineering)

Pattern 'B23'

Effective from Academic Year 2023-24

Prepared by: - Board of Studies in Instrumentation & Control Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – BOS **Chairman – Academic Board**

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Vision statement of Institute

To be globally acclaimed Institute in Technical Education and Research for holistic Socio-economic development

Mission statement of Institute

- To endure that 100% students are employable in Industry, Higher studies, Become Entrepreneurs, Civil/Defense Services / Government Jobs and other areas like Sports and Theatre.
- To strengthen Academic Practices in terms of Curriculum, Pedagogy, Assessment and Faculty Competence.
- Promote Research Culture amongst Students and Faculty through Projects and Consultancy.
- To make students Socially Responsible Citizen.

Core Values

- Faculty Centric Initiatives
- Academic Practices
- Research Culture
- Use of Technology for Social and National Development

Vision statement of Department

To be recognized as a leading contributor in imparting technical education and research in Instrumentation & Control engineering for development of the society.

Mission statement of Department

- To deliver knowledge of Instrumentation and Control Engineering by strengthening involvement of Research institutions and industries in academics
- To build conducive environment for advanced learning through participation of faculty and students in collaborative research, consultancy projects, student exchange programs and internships
- To develop competent Engineers with entrepreneurial skills to address socio-economic needs.

Program Educational Objectives (PEO)

Programme: B. Tech. (Instrumentation and Control Engineering)

The Graduates would demonstrate

1. Core competency in Instrumentation and Control Engineering to cater to the industry and research needs.
2. Multi-disciplinary skills, team spirit and leadership qualities with professional ethics, to excel in professional career and/or higher studies.
3. Preparedness to learn and apply contemporary technologies for addressing impending challenges for the benefit of organization/society.
4. Knowledge of recommended standards and practices to design and implement automation solutions.

Program Outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research –based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

Graduates shall have the ability to:

1. Evaluate the performance of suitable sensors / Process components/ Electronic / Electrical components for building complete automation systems.
2. Analyze real-world engineering problems in the area of Instrumentation and Control.
3. Design or Develop measurement / electronic / embedded and control systems with computational algorithms to provide practical solutions to multidisciplinary engineering problems.

S.Y. B.Tech - Instrumentation and Control Engineering Structure for Pattern B-23, Module-3 with effect from Semester-2 of Academic Year 2023-24

Course Type	Course Code	Course Name	Teaching Learning Scheme (Hrs./Week)				Credits	Assessment Scheme (100 mark scale)											
								In Semester Assessment							End Semester Assessment					Total
			Th	Lab	Tut	Total		Lab 10	CP 20	MSE-MCQ 30	MSE Review 30	Seminar / GD / HA 20			ESE 30			ESE Review 70	CVV 20	100
												Seminar	GD	HA	Written	MCQ	Practical			
S1	IC2222	Advanced Data Structures	2	2	1	5	4	10	20								50		20	100
S2	IC2224	Data Communication	2	2	1	5	4	10	20				20			30			20	100
S3	IC2226	Signal and Image Processing	2	2	1	5	4	10	20			20			30				20	100
S4	IC2228	Industrial Automation	2	2	1	5	4	10	20				20		30				20	100
S5	IC2230	Sensors and Transducers	2	0	0	2	2								100					100
S6	IC2236	Design Thinking-3	0	0	1	1	1													Graded
S7	IC2240	Engineering Design and Innovation - III	0	8	0	8	4				30							70		100
		Total	**10**	**16**	**5**	**31**	**23**	**40**	**80**	**0**	**30**	**20**	**40**	**0**	**160**	**30**	**50**	**70**	**80**	**600**

SEMESTER II

FF No. : 654

IC2222 :: ADVANCED DATA STRUCTURES

Course Prerequisites: Basic understating of C/C++ programming

Course Objectives:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques.
3. To construct and implement various data structures and abstract data types including lists, stacks, queues, trees, and graphs.
4. To make understand about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.
5. To emphasize the importance of data structures in developing and implementing efficient algorithms

Credits: 4 **Teaching Scheme Theory: 2** Hours/Week
Tut : 1 Hour/Week
Lab : 2 Hours/Week

Course Relevance:

In the current scenario there is huge demand in the software industry for a skilled personnel. Data Structures is a basic fundamental course for any student who wishes to make a career in the field of Software industry. Almost every industry working in the software sector be it in the development, service, banking and finance, Data analysis and allied looks for an engineer who has basic programming and analysis skills. Data structures give the students the insights of the working of program and file handling. The course content is included in such a way that the beginner can easily understand the course. The course has hands-on sessions so as to make the learner understand the concepts clearly. Once a student successfully learns the concepts of DS s/he can certainly implement the same in real world engineering applications such as Billing management systems, Database handling, File handling and operations, NLP implementation, Shortest path finding problem solving are to name a few.

Moreover the Students who are aspiring to pursue a master's degree in the field of Engineering are also expected to have a deep understanding of concepts of Data Structures.

This course will develop a core competency in the field of Software technology.

SECTION-1:

Unit-1 : Introduction to DS Sorting and Searching Techniques [6 Hrs]

Types: Primitive, Non primitive, Linear, Nonlinear, Static, Dynamic Single and Multidimensional arrays: Memory representation and indexing, operations on multidimensional arrays. Time & Space Complexity Analysis**.**

Sorting Techniques:

Understanding of Selection, Bubble, Insertion, Merge, Quick, Heap sort techniques.
Understanding Time and Space complexities of the algorithms

Searching: Understanding Linear and Binary Search algorithm and Time and Space Complexities

Unit-2: Stack and Queue DS [4 Hrs]

Stack: representation using array, Applications of stack: Recursion, Validity of parentheses, Expression conversions and evaluations etc.

Queue: representation using array, Types of queue, Applications of Queue: Job Scheduling, Josephus problem etc

Unit-3: Linked Lists and Its Applications [5 Hrs]

Singly Linked Lists, Doubly linked Lists, Circular linked lists, Applications of Linked lists, Stack & Queue using linked list, Polynomial Manipulation using linked list.

SECTION-2:

Unit-4: Trees and Its Applications [6 Hrs]

Basic terminology, representation using array and linked list, Tree Traversals:
Recursive And Non recursive, counting no of Nodes etc., Construction of binary tree from traversals, Binary Search trees(BST): Insertion, deletion of a node from BST. Threaded Binary tree (TBT): Creation and traversals on TBT, Expression Trees, Gaming Trees

Advanced Trees: Introduction, AVL tree, R-B tree, B tree and B+ tree.

Unit-5: Graphs [6 Hrs]

Terminology and representation using Adjacency Matrix and Adjacency Lists,
Graph Traversals and Application: BFS and DFS, Connected graph, Detecting Cycle in graph. Minimum Spanning tree: Prims and Kruskal's Algorithm, Shortest
Path Algorithms, Union Find.

Unit-6: Hashing [3 Hrs]

Hashing techniques, Hash table, Hash functions. Collision handling and Collision resolution techniques. Warshall‟s Algorithm for Finding Transitive Closure.

List of Tutorials (Any 10):

1. Sorting Techniques: Bucket, Heap , Merge sort, Shell Sort, Radix Sort.
2. Searching Techniques: Ternary Search, Fibonacci Search.
3. Problem solving using stack (Maze problem, Tower of Hanoi).
4. Expression conversion like infix to prefix and postfix and vice versa.
5. Priority Queues and Job Scheduling Algorithm.
6. Generalized Linked Lists.
7. Threaded Binary tree and Stack less Traversals using TBT.
8. B and B+ Tree.
9. Applications of Graph in Network problems.
10. Design of Hashing Functions and Collision Resolution techniques.
11. Cuckoo Hashing.

List of Practicals (Any 10):

1. Assignment based on Sorting and Searching.
2. Assignment based on Stack Application (Expression conversion etc.)
3. Assignment based on Queue Application (Job scheduling, resources allocation etc.)
4. Assignment based on linked list.
5. Assignment based on BST operations(Create, Insert, Delete and Traversals)
6. Assignment based on various operations on Binary Tree
7. Assignment based on AVL and R-B tree.
8. Assignment based on DFS and BFS
9. Assignment based on MST using Prim's and Kruskals Algorithm.
10. Assignment based on Finding shortest path in given Graph.
11. Assignment based on Hashing

List of Projects:

1. Implementation of DFS Search algorithms for given application/s
2. Lamentation of BFS Search algorithms for given application/s
3. Implementation of Dijkshetra's shortest path finding algorithm for given application
4. Implementation of A* shortest path algorithm for given application
5. Development of a data base for the students of a class using concepts of Structures
6. Development of Ticket booking system using concepts of Queue and Stack
7. Implementation of Topological sort for given application
8. Billing management system
9. Student database creation using Linked list
10. Expression tree
11. Sudoku solver
12. Dictionary using Tree
13. Maze runner problem solver
14. Calendar application using structures
15. Solving Tower of Hanoi puzzle
16. Calendar Application using File handling.
17. Word Completion Using Tire.
18. Bloom Filters.
19. Scheduling Applications and Simulation.
20. Different Gaming Application

Assessment Scheme:

Course Assessment: Total : 100 mks

1. Lab Assignments : 10 marks (ISA, *100 marks converted to 10)*
2. Course Project : 20 marks (ESA, *100 marks converted to 20)*
3. Programming practical exam : 50 mks (ESA, *100 marks converted to 50*)
4. Viva : 20 mks (ESA, *100 marks converted to 20)*

Text Books:

1. Fundamentals of Data Structures in C", E. Horwitz , S. Sahani, Anderson-Freed, Second Edition, Universities Press.
2. Data structures using C and C++", Y. Langsam, M.J. Augenstein, A.M.Tenenbaum, Pearson Education, Second Edition

Reference Books:

1. An Introduction to data Structures with applications", J. Tremblay, P. Soresan, TMH Publication, 2nd Edition

Moocs Links and additional reading material:

1. nptel.ac.in/courses/106/102/106102064
2. nptel.ac.in/courses/106/105/10610508

Course Outcomes:

The student will be able to –

1. To interpret and diagnose the properties of data structures with their memory representations
2. To comprehend various sorting and searching algorithms.
3. To use linear data structures like stacks, queues etc. with their applications
4. To handle operations like searching, insertion, deletion, traversing mechanism etc. On tree.
5. To demonstrate the use of binary tree traversals and to perform various operations on nonlinear data structures.
6. To implement the graph data structures to solve engineering problems.

CO PO Map:

CO/PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:1	PSO:2	PSO:3
CO:1	1	1	1	0	0	0	0	0	0	0	0	2	0	2	0
CO:2	0	2	2	2	2	0	0	0	0	0	0	0	2	0	2
CO:3	0	0	1	2	2	0	0	0	0	0	0	0	0	2	0
CO:4	2	0	0	1	2	2	2	0	0	0	0	0	0	0	2
CO:5	0	2	0	0	1	2	2	2	0	0	0	0	0	0	0
CO:6	2	0	2	0	0	1	2	2	2	0	0	0	0	0	0

CO attainment levels:

CO No	IC2202_CO1	IC2202_CO2	IC2202_CO3	IC2202_CO4	IC2202_CO5	IC2202_CO6
Attainment level	1	2	2	3	3	4

Future Courses Mapping:

Data Analytics, Data Science, OOPS, Artificial Intelligence, Machine learning, Software Engineering

Job Mapping:

DS is a fundamental course for the students who are aspiring to make a career in the field of Software engineering. Once this course is learned students can apply for a job as a Software developer, Software testing, Data Analyst etc. The course is also helpful for students who are planning to have their own start-ups in the area of Software development.

FF No. : 654

IC2224 :: DATA COMMUNICATION

Course Prerequisites: Computer Fundamentals and C/C++ or Python Programming Language Course

Course Objectives:

1. Study of Basic components of a communication system, Serial Communication Methods, Transmission impairment in data communication, Line Coding, Interface standards**:**RS-232, RS-485, Serial Interconnect Buses I2C, SPI, USB
2. Study of different methods of error detection or control, causes of signal distortion Communication media: guided and unguided
3. Study of different methods of modulation, data compression techniques, Multiplexing,
4. Study of different Industrial Protocol used instrumentation and control system: Modbus, HART Protocol, Open Industrial Fieldbus systems,
5. Study of Local Area Network (LAN), Ethernet, Internet protocol suite, CAN bus.
6. Study of IoT wireless technologies and their use cases: LPWANs, Cellular (3G/4G/5G), Zigbee and Other Mesh Protocols, Bluetooth and BLE, Wi-Fi, RFID.

Credits: 4 **Teaching Scheme Theory: 2** Hours/Week
Tut: 1 Hour/Week
Lab: 2 Hours/Week

Course Relevance:

The key technology of the information age is communications. Data communications and networking is a truly global area of study, both because the technology enables global communication over telephone lines and Internet. Data communication and networking is the backbone of all IT infrastructures in the world. These technologies and applications often emerge in communication within countries of countries and spread rapidly around the world.
Starting from the basics, this course gives you the tools to design and maintain industrial communications systems on plant floor. You'll learn the underlying principles behind today's industrial communications systems, including Modbus, Data Highway Plus, Ethernet, and TCP/IP. Real-life examples and case histories provide insight into the facts behind control networks and how to apply and maintain them effectively in plant.

SECTION-1 :

Unit 1: Overview of Data Communication (6 Hrs.)

Basics of data communication, role of standards and protocols, important physical standards: *typical serial data communications link*, purpose of instrumentation and control system, important control devices: *Graphical representation of data communications*

Baseband and broadband transmission, factors affecting transmission speed: Bandwidth, Signal-to-noise ratio, Data throughput, Error rate

Transmission impairment in data communication: attenuation, distortion, noise.
Shannon capacity (NOISY CHANNEL), Nyquist bit rate (NOISELESS)
Basic components of a communication system
Communication modes: Simplex, Half duplex, Full duplex
Digital Representations of Data, Synchronous and Asynchronous Data communication
Data Rate, Channel Capacity, Error Rate, Noise. Nyquist Sampling Rate, Shannon Channel Capacity, SNR.
Line Coding: Unipolar NRZ, Polar NRZ, NRZ Inverted, Bipolar Encoding, Manchester Encoding, Differential Manchester Encoding.

Serial Data Communication Methods and Interface Standards
Balanced and unbalanced data communication
Function of the important standards organizations, serial data communications interface standards: RS-232, RS-485, Serial interface converters
Serial Interconnect Buses I2C, SPI, USB: basic characteristics, frame format configuration, use cases

Unit 2: Error Detection (5 Hrs.)

Origin of errors: Static events, Thermal noise, Transient events
Factors affecting the propagation of signals: Attenuation Limited bandwidth, Delay distortion, Noise,
Methods of feedback error control: Character redundancy: parity check, Block redundancy: longitudinal parity check, arithmetic checksum, Cyclic redundancy check (CRC), Forward error correction: hamming codes
Communication Media: guided and unguided
General properties and use of Guided media copper-based cables, two-wire open lines, twisted pair cables, coaxial cables, fiber-optic cables, General properties and use of Unguided media

Unit 3: Modems and Multiplexers (4 Hrs.)

Modes of operation of a modem, Describe the different methods of **modulation**: AM, FM, PAM, PWM, PPM, PPM,ASK, FSK, PSK,
Components of a modem: transmitter and receiver
Data compression techniques Run length encoding, Adaptive frequency encoding, enhanced data compression, Huffman encoding
Multiplexing: TDM, FDM, etc.

SECTION-2 :

Unit 4: Industrial Protocols (5 Hrs.)

Modbus structures: Message format, The Modbus messaging protocol, Modbus Serial RTU, Modbus Serial ASCII, Modbus TCP/IP, OSI layers of Modbus
HART Protocol: benefits of the HART protocol, HART Data, communication modes, HART networks, OSI layers of the HART protocol
Open Industrial Fieldbus systems: Benefits**,** comparison traditional system, H1 and HSE links, Integrated Architecture, Fieldbus components, The OSI model and Fieldbus systems, HSE High Speed Ethernet, Examples of various Fieldbus protocols

Unit 5: Local Area Network (LAN), CAN bus (5 Hrs.)

LAN Topologies: Access Mechanisms and Media, Ethernet: specifications and protocols

Internet protocol suite: Basics of TCP/IP Protocols

Controller Area Network (CAN bus): Applications, Architecture, Message Frame Format, OSI reference model for CAN,

Unit 6: Wireless Communications Technologies and Networking (5 Hrs.)

Radio spectrum international telecommunication union (ITU), Microwave basics, Wireless networking components, Introduction to satellite communication,

Types of IoT wireless technologies and their use cases: Low Power Wide Area Networks (LPWANs), Cellular Network 3G, 4G & 5G, Zigbee and Other Mesh Protocols, Bluetooth and BLE, Wi-Fi, RFID, IRDa.

List of Tutorials: (Any Six)

1. Examples and analysis of Unipolar NRZ, Polar NRZ, NRZ Inverted, Bipolar Encoding,
2. Manchester Encoding, Differential Manchester Encoding
3. Examples and analysis on Modulation and demodulation techniques
4. Examples on network performance parameters : RTT, Delay, Bandwidth, Throughput and efficiency
5. Analyze packet formats of Ethernet, IP, TCP and UDP
6. Data Compression Algorithms
7. Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS) used in broadband communication Home automation
8. Any tutorials based on relevant technology with respect to subject data communication.

List of Practical: (Any Six)

1. Programming for different error detection
2. Simulation of I2C and SPI communication Protocol
3. Serial communication simulation using RS-232
4. Serial communication simulation using RS-485
5. Simulation of Modbus
6. Simulation of data communication using Cisco Packet tracer
7. Demonstration of modulation techniques
8. Demonstration Multiplexer techniques
9. Setting up small computer networks
10. UDP Socket Programming using Single Thread.
11. Network simulation using Cloudsim
12. Linux Commands for testing connectivity and transfer rates
13. Any practical based on relevant technology with respect to subject data communication.

List of Projects:

1. Communication Systems Using Python
2. Python networking projects
3. Arduino Long Distance Communication
4. Start Sending Data Over Long Distance using Arduino via Wired and Wireless Connection and extend Arduino Capabilities
5. Arduino SMS Sending Motion Detector using Python
6. CAN bus implementation or simulation
7. Power Line Data Communication
8. LIDAR data acquisition
9. Cryptography / Steganography for secured data communication
10. Green Communications for Future Vehicular Networks
11. UAV-Assisted Data Collection
12. Vehicle speed measurement system
13. Vision based measurement system
14. MODBUS simulation
15. BLE simulation
16. Home automation
17. Develop a tool fox for modulation and demodulation methods
18. Implementation of RIP/OSPF/BGP using Packet Tracer
19. Simulation of routing protocol using Packet Tracer/ NS3/OMNet
20. USB to RS232 serial communication or vice versa
21. Simulation of modulation and demodulation for digital telephone lines
22. Simulation of modulation and demodulation for Ethernet Network
23. Simulation of modulation and demodulation for 3G/ 4G for mobile networks
24. Develop a tool for line encoding methods
25. Design and deploy TCP based Multithreaded HTTP client server
26. Design and deploy UDP based Multithreaded TFTP client server
27. Design and deploy TCP based Multithreaded SMTP and POP3 mail client server
28. Design and deploy TCP based Multithreaded Chat client server
29. Cloud Computing
30. Smart metering
31. Any course project based on relevant technology with respect to subject data communication.

List of Course Group Discussion Topics:

1. Energy-Efficient Architectures For Communication System
2. Satellite Communication System
3. Data Communication in Software Defined Networks
4. Cognitive Radios for Future Communication Frameworks
5. Fast Ethernet (Encoding Framing, Modulation, Multiplexing, Diameter etc)
6. Gigabit Ethernet (Encoding Framing, Modulation, Multiplexing, Diameter etc)
7. 10G Ethernet (Encoding Framing, Modulation, Multiplexing, Diameter etc)
8. IEEE 802.11b protocol based on HR-DSSS for wireless physical layer standard
9. IEEE 802.11g protocol based on ERP-OFDM for wireless physical layer standard
10. IEEE 802.11n protocol based on HT-OFDM for wireless physical layer standard

11. Enhanced Mobile Broadband (e-MBB) and massive Machine Type Communications (mMTC).
12. Industrial Network Considerations
13. Network operating systems and architectures
14. Cryptography / Steganography for secured data communication
15. MIMO Technology For Wi-Fi
16. Underground and underwater data Communications
17. Transmission technologies for 4G mobile networks
18. Transmission technologies for 5G mobile networks
19. Autonomous systems in the Internet
20. Hyperspectral Data Communication
21. Application Protocols and its security

Assessment Scheme:

Course Assessment: Total : 100 mks

1. End Semester Examination: 30 marks (ESA-MCQ, 30 marks)
2. Course Project : 20 marks (ESA, 100 marks converted to 20)
3. Lab Assignment : 10 mks (ISA, 100 marks converted to 10)
4. Viva : 20 mks (ESA, 100 marks converted to 20)
5. Group Discussion: 20 mks (ISA, 100 marks converted to 20)

Text Books:

1. John Park, Steve Mackey, Edwin Wright, Practical Data Communications for Instrumentation and Control, Elsevier Publication
2. Fourauzan B., "Data Communications and Networking", 5th edition, Tata McGraw- Hill, Publications, 2006
3. Andrew S. Tanenbaum, “Computer Networks”,5th Edition, PHI, ISBN 81-203-2175-8.
4. Kurose, Ross “Computer Networking a Top Down Approach Featuring the Internet”, Pearson; 6th edition (March 5, 2012), ISBN-10: 0132856204

Reference Books:

1. Matthew S. Gast “802.11 Wireless Networks”, O’Reilly publications; 2nd Edition.
2. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks: Architectures and Protocols” Prentice Hall, 2004.
3. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, Wiley, ISBN:0-470-09510-5

Moocs Links and additional reading material:

1. Data Communication: *https://nptel.ac.in/courses/106105082*
2. Digital Communication System: *https://nptel.ac.in/courses/106/108/106108098/*
3. Data comm. Virtual lab: *http://eagle-beacon.com/virtuallab/index.html*
4. Basics of Cisco Packet Tracer (Part 1): *https://www.netacad.com/courses/packet-tracer*
5. Advanced Network Technologies Virtual Lab: *http://vlabs.iitkgp.ac.in/ant/*

Course Outcomes:

The student will be able to –

1. Differentiate serial interface techniques, standards, interconnect buses
2. Apply different methods of error detection, control transmission media
3. Analyse different methods of modulation used for data communication and network, data compression techniques, Multiplexing,
4. Describe different Industrial Protocol used instrumentation and control system
5. Understand LAN, Ethernet, CAN
6. Select IoT wireless technologies for various applications

CO PO Map:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	-	-	-	1	-	1	2	-	1	2	2	1
CO2	3	2	-	1	-	1	1	1	1	2	-	1	-	1	2
CO3	2	1	1	1	2	1	1	-	1	2	-	1	-	2	1
CO4	2	1	1	1	1	2	2	1	2	2	1	1	2	2	-
CO5	1	2	2	-	-	1	1	1	2	1	1	1	2	1	-
CO6	1	2	2	1	2	1	1	1	2	1	1	1	1	2	1

CO attainment levels:

CO NO	CO1	CO2	CO3	CO4	CO5	CO6
Attainment level	2	1	2	2	1	3

Future Courses Mapping:

High Speed Networks, Wireless Networks, Mobile Networks, Cyber Security, Network Security And Information System, Cloud Computing And Security.

Job Mapping:

Data Communication Engineer, Network Analyst, Communication Associate, IT Service Delivery Manager, Hardware and Network Engineer, Network Stack Developers, Application Developer, Data Engineer, Computer Network Architect, Line Data Engineer, Network Administrator

FF No. : 654

IC2226 :: SIGNAL AND IMAGE PROCESSING

Course Prerequisites: Mathematics, Mathematical Transforms, Linear Algebra

Course Objectives:

1. Upon completion of this course, students will be familiar with basic signal and image processing techniques for solving real problems.
2. This course will provide understanding to design, implement, and analysis digital system utilizing the signal and image processing techniques

Credits: 4 **Teaching Scheme Theory: 2** Hours/Week
Tut : 1 Hour/Week
Lab : 2 Hours/Week

Course Relevance:

Signal and Image processing course is the basis of machine learning, deep learning, artificial intelligence, robotics, automation, IOT, Industry 4.0

SECTION-1: Signal Processing

Unit 1 : Signals and Systems (5 Hrs)

Signals – Continuous time and discrete time, time shift and time scale operations on signals, sampling, discrete time systems - memory-less systems, linear time invariant systems, causality, stability properties of linear time- invariant systems. Convolution of discrete time sequences, properties of convolution.

Unit 2: Discrete Fourier Transform and Fast Fourier Transform (5 Hrs)

DFT and IDFT:

Fourier transform, Discrete Fourier Transform (DFT): DFT and IDFT, Properties of DFT, Circular convolution, linear convolution using DFT and IDFT

FFT and IFFT

Fast Fourier Transform (FFT and IFFT) – Radix 2 - DIT algorithm

Unit 3: Filter Design (5 Hrs)

FIR Filter Design

FIR filter design using windowing techniques. Low pass, High pass, Band Pass, Band stop filter design by windowing method

Analog Filter design and IIR Filter design

Analog filter design: Butterworth filters, Low pass Butterworth filter design. Digital IIR filter design: Bilinear transformation.

SECTION-2: Image Processing

Unit : 4 Digital Image Fundamentals (5 Hrs)

Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization, Pixel Operations, Distance measurement. Geometric Transformation on image

Image Transformation – 2 -D DFT, 2-D IFFT

Unit 5: Image Enhancement and Restoration (4 Hrs)

Histogram Processing, Histogram equalization.
Spatial Filtering, Smoothing and Sharpening Filters, Median Filter

Unit 6: Image Segmentation (4 Hrs)

Segmentation based on Discontinuities (point, Line, Edge)
Image Edge detection using Robert, Sobel, Previtt masks, Canny's Edge Detector.

List of Tutorials:

1. Sampling theorem – compute and plot the continuous and discrete theorem. Change the sampling frequency and plot the signal on paper.
2. Computation of time shift and time scale operations on discrete signals. Computation of convolution
3. Computation of 1 -D DFT and IDFT - by formula and Computation of 1-D DFT and IDFT – by linear Transformations.
4. Computation of FFT radix 2 – DIT and DIF algorithm. Compare the computational complexity in computing DFT and FFT
5. Designing FIR Filter using windowing technique. Designing low pass IIR Filter using BZT method
6. Computation of Geometric transforms on image – scale, rotate, reflect translate (considering 3*3 matrix)
7. Computation of 2D convolution. Computation of 2 D – DFT and 2D IFFT

List of Projects Areas:

1. Audio signal filtering
2. Biomedical Signal analysis
3. Frequency spectrum analysis
4. Vibration Signal analysis
5. Speech recognition
6. Image filtering
7. Image recognition
8. Image Classification
9. Object detection using image processing
10. Image compression

List of Course Seminar Topics:

1. Signal Processing Applications in sensing and measurement
2. Signal Processing application in Robotics
3. Signal Processing applications in Automation
4. Signal Processing application in Industry
5. Signal Processing application in Space technology
6. Image Processing application in automation
7. Image processing application in robotics
8. Image processing application in Industry 4.0
9. Image processing application in Consumer Electronics
10. Signal processing application in consumer electronics

List of Lab assignments:

Lab1: (i) Plot of continuous time and discrete time sinusoidal signal – understanding the concept of Sampling Theorem. (ii) Time Shift and Time scale operations on Discrete signal. (iii) Linear Convolution

Lab 2: To perform Fast Fourier transforms using radix 2 DIT, algorithms. Also IFFT

Lab 3: (i) FIR filter design by using windowing technique. (ii) IIR Filter Design by using Bilinear Transformations method.

Lab4: (i) Formation of image from a 8*8 matrix, plotting negative image 8*8 matrix. (ii) Geometric operations on a image scale, rotate, reflect translate

Lab 5: 2D FFT of an image

Lab 6: Convolution of kernel and images – Smoothening filter and sharpening filter

Link for MOOCS:

1. Signal Processing - https://nptel.ac.in/courses/117/102/117102060/
2. Image Processing - https://nptel.ac.in/courses/117/105/117105135/

Books

1. J. G. Proakis & D. G. Manolakis, "Digital Signal Processing –Principles, Algorithms and Applications", Prentice Hall of India.
2. E. C. Ifeachor & B. W. Jarvis ,"Digital Signal Processing- A Practical Approach", Pearson Education.
3. Gonzalez Rafael C and Woods Richard E, Digital Image Processing, 3rd Edition, Prentice Hall, 2008.
4. Jain Anil K, Fundamentals of Digital Image Processing, Prentice Hall, 1989

Course Outcomes: The student will be able to

1. **IC2226_CO1**: Digitize the continuous time signal, perform various operations on the signal and analyze the properties of the given digital systems.
2. **IC2226_CO2**: Recognize signal spectrum using DFT, compute and plot the spectrum using FFT, Analyze the signal in the frequency domain. Reconstruct time domain signal using IDFT Compute and plot time domain signal using IFFT Algorithm.
3. **IC2226_CO3**: Design FIR/ IIR filters on paper to meet specific magnitude and phase requirements. Use MATLAB / Python / Scilab/ Octave to design the filters and analyze its response. Analyze the effect of quantization on the response of the digital filters.
4. **IC2226_CO4**: Perform operations on pixel, Perform Geometric transformation on image.
5. **IC2226_CO5** - : Analyze images in the frequency domain using various transforms.
6. **IC2226_CO6** - Evaluate the techniques for image enhancement and image restoration. Interpret image segmentation and representation techniques

CO PO Map:

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2	PSO -3
1	3	3	3	3	3	1	1	1	1	1	1	2	1	3	3
2	3	3	3	3	3	1	1	1	1	1	1	2	1	3	3
3	3	3	3	3	3	1	1	1	1	1	1	2	1	3	3
4	3	3	3	3	3	1	1	1	1	1	1	2	1	3	3
5	3	3	3	3	3	1	1	1	1	1	1	2	1	3	3
6	3	3	3	3	3	1	1	1	1	1	1	2	1	3	3

CO attainment levels

CO No.	IC2226_CO1	IC2226_CO2	IC2226_CO3	IC2226_CO4	IC2226_CO5	IC2226_CO6
Attainment Level	3	5	4	4	4	4

Assessment Scheme:

Course Assessment: Total : 100 mks

1. End Semester Examination: 30 marks (ESA, 100 marks converted to 20)
2. Course Project : 20 marks (ISA, 100 marks converted to 20)
3. Lab Assignment : 10 mks (ISA, 100 marks converted to 10)
4. Viva : 20 mks (ESA, 100 marks converted to 20)
5. Course Seminar: 20 mks (ISA, 100 marks converted to 20)

Future Courses Mapping:

Computer vision, machine learning, deep learning, artificial intelligence, natural language processing

Job Mapping:

Signal and Image processing course may lead to jobs in embedded system, digital system manufacturing industries, software industries for application development, finance software.

FF No. : 654

IC2228:: INDUSTRIAL AUTOMATION

Credits: 4 **Teaching Scheme Theory: 2** Hours/Week
Tut : 1 Hour/Week
Lab : 2 Hours/Week

Course Prerequisites: Fundamentals of Sensors and Transducers, digital electronics

Course Objectives:

1. To understand the working of electrical, hydraulic, pneumatic, mechanical, PLC, drives, HMI and control panel components.
2. Develop electrical wiring diagrams, hydraulic, pneumatic circuits, PLC, SCADA, HMI programs for given application.

SECTION 1:

Unit 1: Industrial Control Devices (5 Hrs)

Switches: construction, working, application of toggle, slide, DIP, rotary, thumbwheel, selector, push button, micro, limit, emergency, process switches, symbols, specifications.

Relays: construction, working, terminologies and applications of Electro-mechanical relay, hermetically sealed relay, reed relay, solid-state relays and timing relay, specifications.

Contactors: construction, working, specifications and applications of contactors.

Motor control circuits: Development of electrical wiring diagram for starting, stopping, reversing, sequencing and interlocking for motors. **Protection of motors:** short circuit, over load protection, low / under voltage, phase reversal, over temperature protection.

Unit 2: Hydraulic Components (5 Hrs)

Hydraulics: principle, block diagram, advantages, disadvantages, applications, hydraulic fluid desirable properties, Types of hydraulic oil and its selection.

Hydraulic components: hydraulic power pack, hydraulic pumps, actuators, filters, piping, heat exchangers valves and motors.

Hydraulic circuits: development of hydraulic circuits using standard symbols, hydraulic circuits like meter in, meter out, reciprocating, speed control, sequencing of cylinders, direction control, deceleration, regenerative circuit, etc. troubleshooting in hydraulic circuits. Introduction to circuit design.

Unit 3: Pneumatic Components (5 Hrs)

Pneumatics: principle, block diagram, advantages, disadvantages, applications. Fluidic elements and its applications

Pneumatic components: pneumatic power Supply, types of pneumatic relay, FRL unit, pneumatic actuator (cylinders and air motors), pneumatic valves,

Pneumatic circuits: development of pneumatic circuits using standard symbols, sequence diagram (step-displacement) for implementing pneumatic circuits, different pneumatic circuits like reciprocating, sequencing, block transfer, speed regulation, job sorting, electro-pneumatic circuits, etc

Mechanical components : Springs and Gears

SECTION 2 :

Unit 4: Programmable Logic Controllers (5 Hrs)

PLC Hardware: Types of Processes, Advantages, Architecture of PLC, Construction and signal processing of DI-DO-AI-AO Modules, working of PLC, Scan time, Source and sink Concepts, Wiring different field Devices to the PLC.

PLC Programming: Development of PLC Programming languages as per IEC 61131-3 like LD, IL, ST, FBD, SFC, addressing, Instructions such as Set-Reset, Latching, Timers and Counters, Advanced PLC Instructions such as Comparison, Data movement, Logical, Mathematical, Program flow control, BIN-BCD, PID, etc and their applications.

Unit 5: Motor, Drives and HMI (5 Hrs)

Stepper motor: principle, types, terminologies, half-stepping and micro-stepping techniques, characteristics, specifications, applications.

Servomotors: construction, working, features, advantages, disadvantages, characteristics of AC and DC servomotor, comparison with stepper motor. AC and DC position and speed control. Synchros for position measurement, position control and error detector.

DC Micro motors: types, construction, working, characteristics and applications.

Drives : Need, Types, Selection criteria, Advantages and disadvantages of drives. Working and construction of VFD, Interfacing of VFD, servo drives to PLC

HMI : Need, Advantages of using HMI, PLC-HMI interface

PLC Interface to Hydraulic/Pneumatic circuits.

Unit 6: SCADA and Control panels: (5 Hrs)

General definition and SCADA components. Need of SCADA system, application & benefits, PLCs Vs RTUs, RTU Block diagram, MTU communication interface, Types of SCADA System, Future trends, Internet based SCADA display system, Comparison of different SCADA packages. Trending, Historical data storage and Reporting, Alarm management. Programming techniques For: Creation of pages, Sequencing of pages, Creating graphics and Animation and development of application using SCADA System.

Control panels

Control Panel: Control panel basics, control room layout, Electric Power Systems, Instrument Power Requirements, Power Distribution, Control Room Lighting, Communication Systems

Control Panel Types, Flat face Panels, Breakfront Panels, Consoles, Comparison of Panel Types, Panel Layout, Control Panel Bid Specifications, Panel Inspections.

List of Practicals: *Students should perform at least 10 practicals out of following*:

1. Implementation of logic circuits using switches.
2. Implementation of relay logic electrical wiring for given application.
3. Implementation of latching, sequencing and interlocking electrical wiring for given application using contactor.
4. Implementation and testing of hydraulic circuit.
5. Implementation and testing of pneumatic circuit.
6. Testing of hydraulic logic circuit using H-simulator.

7. Testing of pneumatic logic circuit using P-simulator.
8. Develop and Simulate Ladder program for simple on-off, timer and counter applications.
9. Develop and Simulate Instruction list, Structure Text programming for given process.
10. Develop and Simulate SFC and FBD for given process.
11. Develop and Simulate applications in PLC using advanced instructions.
12. Interfacing PLC to hydraulic/Pneumatic circuits,
13. Interfacing PLC to HMI, VFD/Inverter, Motion Control/Servo systems to PLC
14. Creating and Configuring a Project and tags in SCADA
15. Develop and simulate the level control loop using SCADA
16. Study of Synchro Transmitter Receiver.
17. Implementation of various operational modes of stepper motor.
18. Study the characteristics of Servo motor.
19. Implementation of motor protection circuits.
20. Demonstration of MCC / control panel components.

List of Tutorials : (Any Six)

1. Develop logic circuits using switches / relays.
2. Develop logic circuits using contactor.
3. Design a Hydraulic circuit for given application.
4. Design a Pneumatic circuit for given application.
5. Develop a Ladder program for simple on-off, IL and ST applications.
6. Develop a Ladder program using timers and counters
7. Develop PLC program using FBD and SFC for given applications.
8. Develop PLC program using advanced instructions of LD for given applications.

List of Course Project areas

1. Industrial Control Devices
2. Hydraulics and Pneumatics
3. Programmable Logic Controllers
4. HMI and Drives
5. SCADA and control panels

List of Course Group Discussion Topics:

1. Recent trends in PLC technology
2. Communication protocols used in PLC
3. Comparison of PLC Programming languages
4. VFD verses Servo drives
5. Special purpose motors
6. Comparison of Control Panels
7. HMI verses SCADA
8. Control panel components
9. Control panel layout
10. PLC Hardware
11. AC-DC Drives

Assessment Scheme:

Course Assessment: Total : 100 mks

1. End Semester Examination: 30 marks (ESA, *100 marks converted to 30)*
2. Course Project: 20 marks (ISA, *100 marks converted to 20)*
3. Lab Assignment: 10 mks (ISA, *100 marks converted to 10)*
4. Viva: 20 mks (ESA, *100 marks converted to 20)*
5. Group Discussion: 20 mks (ISA, *100 marks converted to 20)*

Text Books:

1. F. D. Petruzella "Industrial Electronics", Glancor Publications.
2. Industrial Hydraulics and Pneumatics, Andrew Parr
3. Majumdar, "Pneumatic Systems: Principles and Maintenance", TMH Publications.
4. John Webb, "Programmable Logic Controllers", Prentice Hall of India.
5. B. L. Theraja, "Electrical Technology", S. Chand and Company.
6. Richard Cox, "Programmable Controllers", International Thomson Computer Press.

Reference Books:

1. C.T. Kilian, "Modern Control Technology: Components & Systems", Thomson Learning Publications.
2. "Industrial Hydraulic Technology Parker Motion & Control, Training Department.
3. Festo Controls, "Fundamentals of Pneumatic Control Engineering", Banglore.
4. Frank D Petruzella "Programmable logic controller ", McGraw-Hill Education.
5. SCADA by Stuart A Boyer : ISA 1999

Course Outcomes:

The student will be able to:

1. IC2228_CO1: Comprehend the working of electrical, hydraulic, pneumatic, mechanical, PLC, drives, HMI and control panel components.
2. IC2228_CO2: Develop electrical wiring diagrams, hydraulic, pneumatic circuits for given application.
3. IC2228_CO3: Select and size the electrical, mechanical, hydraulic and pneumatic components to solve a problem.
4. IC2228_CO4: Identify, formulate and solve a problem using electrical, mechanical, hydraulic and pneumatic system.
5. IC2228_CO5: Develop PLC, SCADA, HMI programs for given application.
6. IC2228_CO6: Demonstrate practical knowledge, communication and team skills, by constructing models for real life applications

CO PO Map:

CO	PO -1	PO-2	PO -3	PO -4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO -2	PSO -3
1	3	2	2	1	-	-	-	-	-	-	-	-	1	1	1
2	2	2	3	2	-	-	-	-	-	-	-	-	2	2	2
3	3	3	3	-	-	-	-	-	-	-	-	-	3	2	3
4	2	2	3	2	-	-	-	-	-	-	-	-	2	2	2
5	3	2	3	2	1	1	1	1	2	2	1	1	3	2	3
6	3	2	3	2	1	1	-	1	2	2	1	1	3	2	3

CO attainment levels:

CO No.	IC2228_CO1	IC2228_CO2	IC2228_CO3	IC2228_CO4	IC2228_CO5	IC2228_CO6
Attainment Level	1	2	5	5	3	3

Future Courses Mapping:

Process Instrumentation, Building and Process Automation, etc

Job Mapping:

Industrial Automation is a rapidly evolving field and currently there is a tremendous scope and job opportunities available in the market for Automation Engineers

Some of the exciting and challenging jobs performed by Industrial Controls Automation professionals are:

– Automation Product Manager
– Automation Project Manager
– Industrial Automation Sales Engineer
– Automation Controls Engineer
– Automation Application Engineer
– Field Systems Engineer
– PLC Programmer

FF No. : 654

IC2230:: SENSORS AND TRANSDUCERS

Course Prerequisites: Basic Physics laws.

Course Objectives:

1. Understand working principle of different sensors and transducers
2. Able to evaluate characteristics of sensors and transducers
3. Analyze the mathematical equation and solve different example of sensor
4. Select suitable sensors and transducers for given application
5. Compare different sensors and transducers with their performance
6. Demonstrate practical knowledge, express effectively oral communication and exhibit the skills to work in a team

Credits: 2 **Teaching Scheme Theory: 2** Hours/Week

SECTION 1:

Unit 1: Displacement and non-contact detection Measurement: (4 Hrs)
Transducer definition, classification, and performance characteristics. Resistive: Potentiometer equivalent circuits, charge and voltage sensitivity. Inductive: LVDT, RVDT, variable, reluctance, self-inductance and mutual inductance. Digital transducers: encoders – types of translational and rotary encoders. Proximity sensors: inductive, capacitive, optical, ultrasonic, hall-effect and magnetic. Flapper nozzle: sensitivity, characteristics.

Unit 2: Speed and Vibration Measurement: (4 Hrs)
Stroboscopes, toothed rotor, eddy current, electromagnetic transducers (moving coil, moving magnet), AC and DC tachometers: Hall Effect, proximity pickup, photoelectric, photo-reflective, pulse counting method. Seismic, LVDT, piezoelectric. Weight and Temperature measurement: Strain measurement: principle, strain gauge, types, gauge factor, gauge wire properties.
Comparison of pneumatic, hydraulic and electronic Load cell.

Unit 3: Temperature Measurement: (5 Hrs)
Scales, units and relations, classification of temperature sensors. Mechanical: bimetallic thermometer, its working principle Electrical: Resistance temperature detectors, its types and comparison, circuits for lead wire compensation, Thermocouple: laws of thermoelectricity, terminologies, types (B, E, J, K, R/, S, T), characteristics, study of thermocouple tables, lead wire compensation, cold junction compensation techniques, protection (Thermo well), EMF Measurement methods Thermistor: its types (NTC, PTC), measuring circuits, thermopiles.

SECTION 2 :

Unit 4: Pressure measurement: **(5 Hrs)**
Pressure scales, units and relations, manometers – U tube, well type, inclined tube. Elastic – bourdon, diaphragm, bellows and their types. High pressure measurement– bulk modulus cell, Differential pressure measurement: force balance, motion balance, capacitance delta cell. Vacuum measurement: Units and relations, thermal conductivity (Pirani Gauge, Thermocouple), Calibrating Instruments – Dead Weight Tester (Pressure, Vacuum).

Unit 5: Flow Measurement: (5 Hrs)

Units, Newtonian and non-Newtonian fluids, Reynolds's number, laminar and turbulent flows, velocity profile, Bernoulli's equation for incompressible flow, density, Beta ratio, Reynolds's number correction, square root relation. Head type flow meters: Orifice (eccentric, segmental, concentric), different pressure taps, venture-meter, pitot tube, Variable area type: Rotameter Other flow meters: Turbine, target, electromagnetic, ultrasonic

Unit 6: Level Measurement: (5 Hrs)

Direct (Gauges): Hook type, sight glass: tubular, transparent and reflex, float and tape. Indirect: Hydrostatic pressure, bubbler. Electrical : Float, displacer (torque tube unit), ultrasonic, radioactive, radar (contact, non-contact – TDR / PDS), thermal. Solid level detectors electronic Load cell Float type: float and wire, float and board, capacitive, resistance.

Assessment Scheme:

Course Assessment: Total : 100 mks

1. End Semester Examination: 100 marks (ESA, *100 marks converted to 100)*

Text Books:

1. Nakra-Chaudhary, "Instrumentation Measurement and Analysis", Tata McGraw Hill Publications -21 st Reprint.
2. A. K. Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Sons Publications, 2002.
3. R. K. Jain, "Mechanical and Industrial Measurement", Khanna Publications - 9th print.

Reference Books:

1. B. G. Liptak, "Process Measurement and Analysis", Butterworth Heinemann, Third Edition.
2. E.O. Doebelin, "Measurement System Application and Design", McGraw-Hill International Publications - Fourth Edition.

Course Outcomes:

The student will be able to:

1. IC2230_CO1: Understand the fundamentals of sensors and transducers for mechanical parameters. [1]
2. IC2230_CO2: Demonstrate the working of sensors and transducers for mechanical parameters.[3]
3. IC2230_CO3: Analyze the mathematical equation and solve different example of sensors and transducers for mechanical parameters. [5]
5. IC2230_CO4: Comprehend the fundamentals of sensors and transducers for process parameters.[2]
6. IC2230_CO5: Demonstrate the working of sensors and transducers for process parameters.[4]
7. IC2230_CO6: Analyze the mathematical equation and solve different example of sensors and transducers for process parameters. [5]

CO PO Map:

CO	PO -1	PO-2	PO -3	PO -4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO -1	PSO -2	PSO -3
1	3	2	2	1	-	-	-	-	-	-	-	-	1	1	1
2	2	2	3	2	-	-	-	-	-	-	-	-	2	2	2
3	3	3	3	-	-	-	-	-	-	-	-	-	3	2	3
4	2	2	3	2	-	-	-	-	-	-	-	-	2	2	2
5	3	2	3	2	-	-	-	-	-	-	-	-	3	2	3
6	3	2	3	2	1	1	-	1	2	2	1	1	3	2	3

CO attainment levels:

CO No.	IC2230_CO1	IC2230_CO2	IC2230_CO3	IC2230_CO4	IC2230_CO5	IC2230_CO6
Attainment Level	1	2	5	3	4	2

Future Courses Mapping:

Measurement systems, Process Instrumentation, Building and Process Automation, etc

Job Mapping:

Industrial Automation is a rapidly evolving field and currently there is a tremendous scope and job opportunities available in the market for Automation Engineers

Some of the exciting and challenging jobs performed by Industrial Controls Automation professionals are:

– Automation Product Manager
– Automation Project Manager
– Industrial Automation Sales Engineer
– Automation Controls Engineer
– Automation Application Engineer
– Field Systems Engineer
– PLC Programmer

FF No. : 654

IC2236:: DESIGN THINKING -3

Course Objectives:

To provide ecosystem for students and faculty for paper publication and patent filing.

Credits: 1 **Teaching Scheme** **Tut:** 1 Hours/Week

Topics and Contents:

- Structure of The paper
- Journal List (Top 50 Journals)
- Selection of the journal
- Use of various online journal selection tools
- Plagiarism checking
- Improving contents of the paper
- Patent drafting
- Patent search
- Filing of patent
- Writing answers to reviewer questions
- Modification in manuscript
- Checking of publication draft

Course Outcomes:

The student will be able to

1. IC2236_CO1 : Understand the importance of doing Research
2. IC2236_CO2 : Interpret and distinguish different fundamental terms related to Research
3. IC2236_CO3 : Apply the methodology of doing research and mode of its publication
4. IC2236_CO4 : Write a Research Paper based on project work
5. IC2236_CO5 : Understand Intellectual property rights
6. IC2236_CO6 : Use the concepts of Ethics in Research
7. IC2236_CO7 : Understand the Entrepreneurship and Business Planning

CO-PO Mapping :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	0	0	0	0	0	0	1	0	1	1
CO2	1	1	1	1	1	0	0	0	0	0	0	1	0	1	1
CO3	2	2	3	3	2	2	1	2	2	3	0	1	1	1	1
CO4	3	3	3	3	3	2	1	2	2	3	1	1	1	1	1
CO5	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1
CO6	2	2	2	2	2	2	1	3	2	3	0	1	0	0	1
CO7	1	1	1	1	1	0	0	0	0	0	0	1	0	0	1

CO attainment levels:

CO No.	IC2236_CO1	IC2236_CO2	IC2236_CO3	IC2236_CO4	IC2236_CO5	IC2236_CO6	IC2236_CO7
Attainment Level	2	2	3	6	2	3	2

FF No. : 654

IC2240:: ENGINEERING DESIGN AND INNOVATION-3

Course Prerequisites: Electronic design, simulation, MATLAB, Labview, PCB design

Course Objectives: The student will be able to

1. Understand the importance of choosing socially relevant areas for project work
2. Understand the importance of Project centric learning
3. Plan and execute systematic strategy to complete the Project work
4. Document and present the completed project work in proper scientific format
5. To Evaluate alternative approaches, and justify the use of selected tools and methods
6. To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.
7. To develop an ecosystem to promote entrepreneurship and research culture among the students

Credits: 6 **Teaching Scheme Theory:** Hours/Week

Tut: Hours/Week

Lab: 12 Hours/Week

Course Relevance: This course will develop

1. Awareness about project centric learning will be quite useful in professional work in future
2. Self learning ability to up skill and upgrade once knowledge continuously
3. Ability to work in a Team and Team leadership which will be useful while doing B.Tech Major projects

Topics and Contents

It is based on Real time project implementation in the chosen specific defined area.
Agriculture Healthcare Automotive Process Control IoT

Basics for Projects

Importance of Project Centric Learning, Concept of Domains, Tools and Technology**,** Socially Relevant Project Areas

Domain Project Areas: Awareness and identification of appropriate areas for project work such as: Agriculture, Defense, Healthcare, Smart city, Smart energy, Security Systems, Automobile, Space, Green Earth, Automobiles, Assistive Aid, Water Management, Swachh Bharat (any other socially relevant research area)

Tools: *Self learning Activity* Learn and use latest engineering tools as per the project need. A few are listed below

Tools in Computer Engineering:

Programming / Coding Tools :- JavaScript, Python, Java, C#, C++, PHP, **Computer Vision Tools** :- OPENCV,MATLAB), **Single board computers:** Raspberry Pi, **Neural network simulators Tools:- Neural Lab, NEST , Machine Learning Tools:- Torch, TensorFlow, Data Science Tools :-** R language programming**,** SQL,

Tools in Electronics and Electronics & Telecommunication Engineering:
Electronic Design Simulation Integrated Circuit Tools:- VHDL, Xilinx, Modelsim , Cadence learn, **Embedded System Tools**:- AVR Studio, Arduino ,Kiel µvision, **Circuit Simulation Tools:-** Pspice, Simulink, Workbench, Tinkercad, ThingSpeak, Proteus, CircuitPro ,**Processor based integrated circuits** :Microcontroller, electronic prototype platforms: Arduino,**Networking Tools** :- Wired / Wireless and Ad-hoc Networking NS-2 , Packet Tracer, **Signal Processing Tools**:- Code Composer Studio along with Integrated circuits
Tools in Instrumentation and Control Engineering:-
System Automation Tools :- PLC , SCADA , PADS, ORCAD ,Eagle, Kicad,
Tools in Mechanical, Industrial, Production, Engineering:-
Engineering Design Tools:- AutoCAD, CATIA,COMSOL Multiphysics, Solidworks, Inventor, PTC Creo **Fluid Dynamics:-** Fluent, HyperWorks, **Finite Element/ Structural Analysis:-** Ansy's, Ansy's Free Student software **Thermal Simulation:-** FlowTherm, Ansys Icepak
Tools in Chemical Engineering :-
Chemical process simulator:- DWSIM - Open Source Process Simulator, **chemical simulation software:-** Schrödinger,
(any other suitable tool as per the project requirement)
Technology: Map the appropriate technology**:**
Emerging Technologies :- Artifical Intelligence, 5G networks, IoT, Serverless Computing, Blockchain , Virtual reality (VR)/Augmented reality (AR), Drone, Quantum Computing, Robotics
Interdisciplinary Technologies:- Nanotechnology, Nanomaterials, Nanoelectronics, Quantum Computing , Spintronics
Computer Technologies:- Big Data, Cloud Computing, Human Machine Interface (HMI),Cyber Security
Medical and Healthcare Technologies:- Biomedical Technology,
Energy Technologies :- Solar Energy Based Technologies, Wind energy, Green energy Technologies, Energy Storage
Electronics, Communication Technologies:- Wireless, GPS, Bluetooth, Mobile/social Internet Automation, Mobile Technologies, Voice Assistants, signal processing, image processing, Machine vision, Sensors, Optoelectronics,
Other imp Technologies:- Automobile ,3 D printing
(any other technology as per the project requirement)

Project Implementation: Selection of the domain area, Literature review, Identify and finalize the Problem Statement (student in consultation with Guide), Understand and select and use the appropriate tools, Map the technologies learned with the project needs (refer available online offline Resources, books, soft materials, relevant MOOCs, consult with domain expertise) Self Learning:- learn the required tools, skill sets, acquire knowledge to do the project
Designing & Testing: Designing of project prototype based on domain areas by incorporating appropriate tools and technology, validation and Testing of the prototype to give the best possible solution

Documentation and Final Assessment : Develop and demonstrate the optimized prototype /working model of project , Documentation of project report in stipulated standard format as per the preset norms i.e. IEEE Research paper format, Present Project work at final viva voce

Course Outcomes:

1. Design solutions for given engineering problem **(1)**
2. Demonstrate practical knowledge by constructing models/algorithms for real time applications (**1)**
3. Express effectively in written and oral communication (**2)**
4. Exhibit the skills to work in a team or individually **(2)**
5. Prepare a time chart and financial record for execution of the project **(3)**
6. Choose and compare alternative approaches to select most feasible one **(2)**

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	2	2	2	2	1	1	2	2	1	1	3
CO2	2	2	2	2	3	1	2	1	1	0	2	1	2	2	3
CO3	1	1	1	1	0	2	1	3	1	3	1	1	1	1	1
CO4	1	0	0	2	0	1	1	2	3	2	1	1	0	1	0
CO5	1	0	0	1	0	2	1	1	2	2	3	2	0	2	2
CO6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0