**Annexure-I**

**MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO**

**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUE OF INFORMATION AND COMMUNICATION TECHNOLOGIES**

**MASTER OF ENGINEERING**

**IN**

**INDUSTRIAL AUTOMATION & CONTROL (IAC)**

**FRAMEWORK OF COURSES AND CURRICULUM**

**(FROM BATCH 2023 TO ONWARDS)**

**OVERVIEW:**

1. **SCOPE OF THE PROGRAM:**

There is a global shortage of automation, instrumentation, and control engineers due to the rapid growth of new industries and technologies. The Master of Engineering (Industrial Automation and Control) addresses the growth and new technologies in the Industrial Automation industry. The Master of Engineering (Industrial Automation and Control) offers twelve core courses and a project thesis to provide the knowledge and skills required for this industry. Automation and control engineering is a diverse and rapidly expanding discipline which has become increasingly important in a wide range of industries. The program provides practicing engineers with advanced yet practical tools in the development, integration, and operation of computer-based control and automation systems. The duration of the program is two years and it is an important and job orienting in nature.

Automation and control are important aspects of modern manufacturing and utility supply. Many manufacturing assembly lines and processes utilize programmable control systems. It is essential to equip the prospective engineer in this field with the appropriate theoretical and practical knowledge. This course will extend the students skills across essential areas in the field of automation and control. Student will use the existing knowledge of engineering theory and practice as the base to build new skills in this field such as embedded systems and control system design. Student will also learn to use Programmable Logic Controllers (PLCs) and Supervisory Control and Data Acquisition (SCADA) systems, Robotic and Automation, the industry standard for the development of effective control systems. Furthermore, Industrial Process Control Systems combines the process identification and feedback control design with a broad understanding of the hardware, system architectures and software techniques widely used to evaluate and implement complex control solutions and Machine Learning for Industrial Automation provides the intelligent control basics in the automation area.

This course is valuable for those aspirants looking forward for a bright career in the automation and control field and provides ample job opportunities.

1. **AIM AND OBJECTIVES:**

The aim of this program is to give the technical knowledge necessary to devise innovative solutions and systems in the broad field of industrial automation and control.

The objectives are:

1. To equip the postgraduate students with technical as well as theoretical knowledge of industrial automation modern trends.
2. To give in-depth knowledge of control systems related to industries.
3. To equip students with understanding of industry standards.
4. **ELIGIBILITY OF THE PROGRAM:**

Students with a background in electronics, electrical, mechatronics, instrumentation & control, industrial Electronics, computer systems engineering, Bio medical engineering would benefit from this program as it prepares them for automation in the process and manufacturing industries.

**Eligibility:**

Sixteen years of schooling or 4-year education after HSSC in relevant discipline from HEC recognized degree awarding institutes, with following minimum GPA or marks:

2.5 CGPA or 60% marks

**Entry Test:**

MUET GAT General Test must be passed with a minimum 50% cumulative score prior to admission in the MS Program. Valid result of NTS GAT General Test with a minimum 50% cumulative score can be accepted in lieu of admission test.

**Interview:**

Candidate has to appear in interview

1. **Career and Job Placements**

Candidates can find career opportunities in industries such as:

* Automation and Control Industries
* Automotive Industries
* Oil and Gas/Power Generation/Energy Companies
* Process and Petrochemical
* Manufacturing
* Biomedical
* Aerospace
* Engineering Research.

**PROPOSED FRAMEWORK OF M.E COURSES IN INDUSTRIAL AUTOMATION AND CONTROL (IAC)**

Effective from 23-Batch

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| --- | --- | --- | --- |
| **S. No.** | **Subject Title** | **Course Code** | **Credit Hours** |
| **1st Semester** | | | |
| 1. | Linear Control Theory | IAC-601 | 3+0 |
| 2. | Data Acquisition and Sensing Technology | IAC-606 | 2+0 |
| 3. | Industrial Electronics and Motors Drives | IAC-611 | 3+0 |
| 4. | Industrial Automation | IAC-616 | 3+0 |
|  |  | **Total** | **11** |
| **2nd Semester** | | | |
| 1. | Robotics and Automation | IAC-621 | 2+0 |
| 2. | Industrial Process Control Systems | IAC-626 | 3+0 |
| 3. | Advanced Digital Signal Processing | IAC-631 | 2+0 |
| 4. | Advanced Embedded Systems | IAC-636 | 3+0 |
|  |  | **Total** | **10** |
| **3rd Semester** | | | |
| 1. | Machine Learning for Industrial Automation | IAC-641 | 3+0 |
| 2. | Research Methodology | IAC-646 | 2+0 |
| 3. | Advanced Control Systems | IAC-651 | 3+0 |
|  |  | **Total** | **08** |
| **4th semester** | | | |
| 1. | Project Thesis |  | 0+6 |
|  |  | **Total** | **06** |

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**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Linear Control Theory (IAC-601)**

Disciplines : Industrial Automation and Control

Term : 1st

Effective : 23 batch & onwards

Pre-requisites : Control systems

Marks : Theory: 100 Practical: 00

Credit Hours : 3+0

Minimum Contact Hours : 42+0

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| Aims: | This course is designed to familiarize the students with linear control theory. |
| Objectives: | After completion of this course, students would be able to:   * Represent linear systems using transfer function and state space representation. * Perform analysis of linear control systems in time domain and frequency domain. * Transform models between continuous and discrete time, and between state space and transfer function matrix representations. * Model and analyze systems using state space approach * Design and tune parameters of controllers with LQR and pole placement. |

**Contents:**

Theory for linear multivariable systems; modeling of linear time invariant systems in continuous and discrete time; stability, Routh’s stability criterion, analysis of feedback control systems; root locus, bode plots, Nyquist stability criterion, steady-state errors; methods for construction of multivariable controllers for linear systems, state space models, controllability and observability, formation and solution of state equations, eigenvalues and eigenvectors, transfer function matrix representation of multivariable linear systems, state feedback control, LQR optimal control, state estimation, PID controller.

**Recommended Books:**

1. K. Ogata, “Modern Control Engineering”, Prentice Hall, Latest Edition.
2. B.C. Kuo, “Automatic Control Systems”, Latest Edition
3. R. C. dorf, “Modern Control Systems”, Eddison Wesley, Latest edition
4. Chi-Tsong Chen, “Linear system theory and design”, Oxford University Press, New York, latest edition.

Approval:

Board of Studies Res. No.1.1 Dated: 01.04.2022

Board of Faculty Res. No. 19.5 Dated:03.06-2022

ASRB Res. No. Dated:

Academic Council Res. No. Dated:

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**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Data Acquisition and Sensing Technology (IAC-606)**

Disciplines : Industrial Automation and Control

Term : 1st

Effective : 23 batch & onwards

Pre-requisites : Measurement and Instrumentation

Marks : Theory: 50 Practical: 00

Credit Hours : 2+0

Minimum Contact Hours : 28+0

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| Aims: | This course is divided into two main categories. (1) Designing of sensors with appropriate electronic interface as a complete system. (2) Theoretical understanding of various physical phenomena behind the operation of different types of sensors and microcomputer systems |
| Objectives: | * Study of transducers and measurement techniques. * Fully understand the concept of data acquisition systems. * Differentiate different hardware used for DAQ. * Data conversion and computer data acquisition methods for industrial application. * Understanding of interfaces used in data acquisition and standalone instruments to real-world signals in industrial plants. * Develop judgment of what sensors and modalities are appropriate for different applications |

**Contents:**

Sensors &Transducers; Signal conditioning; Signal source and measurement system; Principle, construction and design of various active and passive transducers. Plug-in DAQ systems, Signal conditioning, Analog to Digital (A/D) converters; Digital to Analog (D/A) converters, Microprocessors and microcontrollers, Amplifiers, Filtering in DAQ; Introduction to transmitters, two wire and four wire transmitters, Smart and intelligent transmitters.

Sensors vs Transducers, Transducer principles & classification (resistive, inductive, piezo-electric, photoelectric, capacitance); Data communication; Ethernet-based systems; Wireless.

Types of sensor, commonly used sensors for various applications; Design of signal conditioning circuits for various Resistive, Capacitive and Inductive transducers and piezoelectric transducer.

**Recommended Books:**

1. “Signal Conditioning and Pc-Based Data Acquisition Handbook: A Reference on Analog and Digital Signal Conditioning for Pc-Based Data Acquisition” by Steve Lekas; latest Edition
2. Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited (2007).
3. Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall Private Limited (2006).
4. Dunn, 2005, “Fundamentals of Industrial Instrumentation and Process Control”, McGraw-Hill Education, Latest Edition,ISBN: 978-0071457354.

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**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Industrial Electronics and Motors Drives (IAC-611)**

Disciplines : Industrial Automation and Control

Term : 1st

Effective : 23 batch & onwards

Pre-requisites : Power Electronics

Marks : Theory: 100 Practical: 00

Credit Hours : 3+0

Minimum Contact Hours : 42+0

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| Aims: | This subject aims to provide students with an in-depth knowledge about the various types of motors and drives used in industries. |
| Objectives: | Students will learn the dynamics of electric motors. In addition, they will also learn the characteristics of D.C motors and Drives, AC Motors and Drives. Student will also get familiarization with Stepping Motors modes of excitation and control circuit and Servo Motor-Closed Loop Control System. |

**Contents:**

Motoring condition and behavior with and without mechanical load, General Properties of Electric Motors. Steady-State Characteristics of DC motors, Dynamic behavior and time-constants of DC motors, Types of DC motors, Control Arrangements for D.C. Drives (Current, Torque, Speed), Load Characteristics of DC Drives, Four quadrant Operation of DC Drives, D.C. Servo Drives. Construction of 3-phase Induction Motors- Rotating magnetic field, Slip and Torque production. Operation and characteristics of Servo Motor, Speed Control of servo motors, Chopper-Fed D.C. Motor Drives, Stepper Motor Control Circuits, Variable frequency drive systems, AC voltage control of AC motors.

**Recommended Books:**

1. Austin Hughes and Bill Drury, “Electric Motors and Drives: Fundamentals, Types and Applications”, latest edition, Published by Elsevier
2. Shaahin Filizadeh, “Electric Machines and Drives Principles, Control, Modeling, and Simulation”, Latest Edition, Publisher: Routledge Taylor and Frahcis Group
3. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control, Latest Edition.

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**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Industrial Automation** **(IAC-616)**

Disciplines : Industrial Automation and Control

Term : 1st

Effective : 23 batch & onwards

Pre-requisites : Digital Logic Design

Marks : Theory: 100 Practical: 00

Credit Hours : 3+0

Minimum Contact Hours : 42+0

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| Aims: | This subject aims to provide students with an in-depth knowledge about the industrial automation process using Programmable Logic Control (PLC), Distributed Control System (DCS) and Supervisory Control and Data Acquisition (SCADA) system and to utilize these systems for logic and control execution of industrial applications. |
| Objectives: | * Students will learn to develop the different logics and network configurations using ladder logic diagrams for timers, counter, sequencer and comparators applications. * To give basic knowledge on the architecture and local control unit of Distributed Control System. * To make students familiar with SCADA system architecture, operational types and generations, SCADA communication protocols and technology user interfaces. * To discuss Applications of SCADA in different critical infrastructures |

**Contents:**

Life before PLCs: switches, contacts, fuses and relay logics, PLCs system elements and input/output modules. Relay logic diagram, PLC programming languages classification: textual language and graphical language, PLCs ladder logic programming symbols and signals, Convert relay logic schematics to ladder logic, writing simplified and complex PLCs program using ladder logic, ladder diagrams design configuration and network implementation. Timers as an application of PLCs, on delay and off delay timers, ladder logic diagram examples of timers, Counters as an application of PLCs, up and down counters, ladder logic diagram example of counters, Sequencers as an application of PLCs, time driven and event driven sequencer, ladder logic diagram examples of sequencer, Comparators as an application of PLCs, combinational and bit magnitude logic circuits, ladder logic diagram examples of comparators.

Automation Process, Evolution of DCS, DCS Architectures, DCS Subsystem Network Elements, DCS communication, DCS Servers, DCS Workstations and Process monitoring, DCS Operator interfaces, Industrial Case studies in DCS. Evolution of SCADA, SCADA system Elements and Architecture, SCADA System Functions, Use Case Diagram for SCADA System. First generation- Monolithic, second generation- Distributed, third generation – Networked Architecture. SCADA System Layers, SCADA Communication System, Layer, Open Systems Interconnection (OSI) Model, TCP/IP protocol, Modbus model, DNP3 protocol, IEC61850 layered architecture, IEC 61850 Communication Service Mapping. Human-to-Human interface (HHI), Human- to- Machine interface (HMI), Machine- to- Machine interface (MMI). SCADA system in critical infrastructures: Electric Utility Control Center and Energy management system (EMS), Oil and Gas, Water Purification System and distribution system.

**Recommended Books:**

1. Garry Dunning, “Introduction to Programmable Logic Controller “, Publisher: Thomson\_ Delmaar learning, latest edition.
2. Kelvin T. Erickson, “Programmable Logic Controllers: An Emphasis on Design and Application”, Latest edition.
3. MadhuchhandaMitra, Samarjit Sen Gupta Programmable Logic controllers and Industrial Automation: Penram International Publishing India Pvt. Ltd
4. Stuart A. Boyer, “Supervisory Control And Data Acquisition – Ebook”, Latest Edition.
5. Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols”, Publisher: ELSEVIER
6. Francis G.L, “SCADA: Beginner's Guide”, Latest Edition.

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**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Robotics and Automation (IAC-621)**

Disciplines : Industrial Automation and Control

Term : 2nd

Effective : 23 batch & onwards

Marks : Theory: 50 Practical: 00

Credit Hours : 2+0

Minimum Contact Hours : 28+0

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| Aims: | The aim of this course is to present an introduction of Robotic and automation for Industrial applications. This Course deals with electrical and electronic controls in automation and devoted to robotic and applications of robotics in industry |
| Objectives: | * Understand the fundamental principles of Robots and its classification * Fully understand the concept of Robot Sensors, End effectors and Grippers * Study the different industrial applications of Robots * Fully understand the usage of automation |

**Contents:**

Industrial Robot, laws of Robotics, Comparison of Human and Robot manipulator, Classification of Robots on the basis of Co-ordinate systems, power source, method of Control and Programming method, Robot Selection. Types of Sensors in Robots, External, Tactile, Proximity, Range, computer vision, Velocity, Internal. End effector, Classification of End Effector, Grippers, types of Grippers, Types of Tools, Characteristics of End-of-Arm tooling, Elements of End-of -Arm tooling. Manufacturing Applications, material handling Applications, Robots using Real-Time Embedded systems, Future trends. Goals of Automation, Low cost Automation, Types of Automation, Current emphasis in Automation. Electrical and Electronic Controls, Transfer devices and feeders.

**Recommended Books:**

1. Robotics and Automation handbook, Thomas R. Kurfess Ph.D., P.E. CRC Press.
2. Industrial Automation and Robotics, A.K Gupta and S.K Arora
3. The Future of Leadership, Rise of Automation, Robotics and Artificial Intelligence, Brigette Tasha Hyacinth

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**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Industrial Process Control Systems (IAC-626)**

Disciplines : Industrial Automation and Control

Term : 2nd

Effective : 23 batch & onwards

Marks : Theory: 100 Practical: 00

Credit Hours : 3+0

Minimum Contact Hours : 42+0

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| Aims: | This course is intended to familiarize the student with the most important aspects of Distributed Control Systems and techniques employed in the automated control of industrial processes.  . |
| Objectives: | Understand basic principles and importance of process control in industrial process plants.  To introduce the dynamics of various processes and modelling of physical processes using first principles.  To give basic knowledge on the architecture and local control unit of Distributed Control System (DCS).  To model and design the Virtual Instrumentation for industrial process control. |

**Contents:**

Overview of process characteristics: gain, dead time, response curve, Process Variables, Manipulated Variables and Set Points; Input/output relationships of typical process equipment modules: Tanks, Heat exchangers, reactors, Process unit operations, Flowcharts and the depiction of the control system; Overview of single control loops: level, temperature, pressure, and flow; linear differential equations and Introduction to process dynamics; Basic characteristics and terminologies of process control,Design aspects – Hardware elements of process control system, Mathematical modeling of processes: Fundamental laws and equations – level, thermal, flow, gas and mixing process, Interacting and non – interacting process – self-regulation – inverse response – degrees of freedom – linearization – transfer function representation of process – variable gain, variable time constant. Design equations – degrees of freedom – poles and zeros – number of controlled and manipulated variables – generation of alternative loop configurations – extension to systems with interacting units, Interaction of control loops – relative gain array – selection of loops – design of non-interacting control loops. Decoupling control. The laws of Thermodynamics; Concepts of heat and mass transfer; Introduction to chemical reaction engineering; First principle modelling; Linearization. Basics of virtual instrumentations, Virtual instrument v/s traditional instrument, Role of hardware and software in virtual instrumentation, Virtual instrumentation for test, industrial I/Os, control and design, basics of LabVIEW, Graphical system design using LabVIEW, Modular programming in LabVIEW.

**Recommended Books:**

1. King. 2016, “Process Control - A Practical Approach”, John Wiley & Sons, Latest Edition – ISBN: 978-1-119-15774-8.
2. Dale R. Patrick, Stephen W. Fardo, “Industrial Process Control Systems”, River Publishers, ISBN: 978-1-00315-153-1
3. Altmann, D. Macdonald, 2005, “Practical Process Control for Engineers and Technicians”, Elsevier, Latest Edition – ISBN: 978-0-7506-6400-4.
4. Mandal, Ajit K., 2017, “Introduction to Control Engineering - Modeling, Analysis and Design”, New Academic Science, Latest Edition – ISBN: 978-1-78183-099-4.

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**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Advance Digital Signal Processing (IAC-631)**

Disciplines : Industrial Automation and Control

Term : 2nd

Effective : 23 batch & onwards

Pre-requisites : Digital Signal Processing

Marks : Theory: 50 Practical: 00

Credit Hours : 2+0

Minimum Contact Hours : 28+0

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| Aims: | This course would develop a sound understanding of Digital Signal Processing, its theoretical background as well as its applications and implementation design. |
| Objectives: | This course would elaborate the time domain as well as frequency domain characteristics of discrete time signals and systems. Review of random signals, LTI systems. Multirate Signal Processing: Interpolation and Decimation, Sample Rate Conversion, Oversampled Processing (A/D and D/A conversion). Time-Frequency Representations: Filterbanks/Wavelets, Prediction; Wiener filters; LMS and RLS adaptive filters, Non-parametric and parametric methods; periodogram; eigenanalysis algorithms |

**Contents:**

Convolution and correlation; random signals; linear time-invariant systems; transforms. AD/DA; aliasing; quantization; oversampling. FIR and IIR filter design; implementation. Interpolation and decimation; filter bank design; polyphase structures. Prediction; Wiener filters; LMS and RLS adaptive filters. Non-parametric and parametric methods; periodogram; eigenanalysis algorithms

**Recommended Books:**

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 4th Ed., Prentice Hall, 2006
2. Digital Signal Processing: A Practical Approach. By Emmanuel C. Ifeachor, Barrie W. Jervis. Published by Prentice Hall, 2002
3. M. Vetterli, J. Kovacevic, and V. K. Goyal, Foundations of Signal Processing, Cambridge, 2014.
4. P. Prandoni and M. Vetterli, Signal Processing for Communications, EPFL Press, 2008.

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**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Advanced Embedded System (IAC-636)**

Disciplines : Industrial Automation and Control

Term : 2nd

Effective : 23 batch & onwards

Marks : Theory: 100 Practical: 00

Credit Hours : 3+0

Minimum Contact Hours : 42+0

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| Aims: | The course is geared towards the development of skills to design and implement practical embedded systems. |
| Objectives: | This course covers the principles of embedded systems inherent to many hardware platforms and applications being developed for ubiquitous systems. The course contains the design of embedded and ubiquitous computing systems including their hardware and software architectures, design methodologies and tools, and communication protocols. |

**Contents:**

Introduction to Embedded Systems; basic design principles including specification and modeling, hardware components and platforms; software organization; interfacing with external environments using sensors and actuators; communication in distributed embedded systems; Embedded Computing: Fundamental problems in embedded computing, Reliability and security; Hardware and Software Co-design: Platforms for hardware/software co-design, Hardware/software partitioning, Hardware/software co-synthesis onto different types of platforms, Hardware/software co-simulation; Embedded SoPC (System on Programmable Chips), Xilinx boards.

**Recommended Books:**

1. Frank Vahid& Tony D. Givarigis, “Embedded System Design: A unified Hardware/Software Introduction”, Latest edition.
2. Wayne Wolf, 2007*,”* High-Performance Embedded Computing: Architectures, Applications, and Methodologies, Morgan Kaufman Publishers, Latest Edition.
3. Ron Sass, Andrew G. Schmidt “Embedded Systems Design with Platform FPGAs: Principles and Practices”, Morgan Kaufman Publishers, Latest edition.

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**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Machine Learning for Industrial Automation (IAC-641)**

Disciplines : Industrial Automation and Control

Term : 3rd

Effective : 23 batch & onwards

Pre-requisites :

Marks : Theory: 100 Practical: 00

Credit Hours : 3+0

Minimum Contact Hours : 42+0

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| Aims: | This course addresses machine learning and its application to industrial automation. |
| Objectives: | In this course the student will be introduced to supervised learning, clustering, regression and time-series analysis. Data pre-processing and system evaluation will be explored.  A series of sub-topics will address the characteristics of commonly used algorithms such as Decision Trees, K-Nearest Neighbours, Neural Networks, linear regression, and K-Means Clustering.  Different applications of machine learning to industrial automation will be explored. This will include condition monitoring, system identification, and image processing for autonomous vehicles. Software tools that can be used to implement machine learning algorithms will be presented. The student will be able to use such tools to apply machine learning to a particular industrial automation problem. |

**Contents:**

Classification, Regression, Time-series analysis, Supervised learning, Clustering, Knowledge representation. Feature vectors, Feature selection, Dimensionality reduction (Principle Component Analysis), Data preparation into training, validation and test datasets Cross-validation, ROC (Receiver Operating Characteristic) curve, Recall-precision curves; Evaluating numeric prediction: root mean-squared error, root relative squared error, correlation coefficient, Overfitting and generalization. Review of Pandas, Numpy and Matplotlib, Scikit-learn, Statsmodels, Tensorflow.K-Nearest Neighbours; Naïve Bayes; Decision Trees; Association rules; K-Means clustering; Numeric prediction: Linear Regression; Decision boundaries; Linear classification: Logistic Regression, The Perceptron; Neural Networks; Multilayer Perceptron; Gradient descent; Training using error backpropagation; Neural Networks as classifiers.WEKA, Matlab/Octave; Cloud-based platforms: Amazon, Microsoft, Google, IBM.Industrial IoT, Artificial Intelligence for Industrial IoT, Condition monitoring, System identification, Autonomous vehicles, Image processing for autonomous vehicles.

**Recommended Books:**

1. Bonnin, Rodolfo, “Machine Learning for Developers”, Packt Publishing,2017, ISBN 978-1-78646-987-8.
2. Lucci, Stephen Kopec, Danny, “Artificial Intelligence in the 21st Century”, 2nd Edition, Mercury Learning and Information, 2016, ISBN 978-1-942270-00-3.
3. Davies, E. R., “Computer Vision - Principles, Algorithms, Applications, Learning”, 5th Edition, Elsevier, 2018, ISBN 978-1-942270-00-3.

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**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Research Methodology (IAC-646)**

Disciplines : Industrial Automation and Control

Term : 3rd

Effective : 23 batch & onwards

Marks : Theory: 50 Practical: 00

Credit Hours : 2+0

Minimum Contact Hours : 28+0

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| Aims: | The aim of this course is to provide students knowledge pertaining to research methodologies in general, with an overview of different analytical procedures and processing of data |
| Objectives: | Upon successful completion of this course students are expected to   * Comprehend the meaning of research, research objectives, types of research and research process * Be able to identify research problem, or formulate it and be able to prepare research proposal * Gain knowledge of various kinds of research techniques, questions and understand different research designs * Apply sampling design, data collection methods, their processing and analysis * Define hypothesis and their testing * Apply procedures to analyze the results and interpret them * Be familiar with report writing skills |

**Contents:**

Meaning of Research. Objectives of Research. Types of Research. Research Approaches. Research Methods vs. Methodology. Research and Scientific Method. Research Process. Criteria of Good Research. Selecting and Defining the Research Problem. Necessity of Defining the Problem. Techniques for Defining a Research Problem. Review of Literature and its Uses. Sources of Information. Research Design and its Necessity. Features of a Good Research Design. Concepts Related to Research Design. Different Research Designs. Principles of Experimental Designs. Sampling Design: Census and Sample Survey. Steps in Sampling Design. Criteria of Selecting a Sampling Procedure. Characteristics of a Good Sample Design. Different Types of Sample Designs. Selection of a Random Sample. Random Sample from an Infinite Universe. Methods of Data Collection: Collection of Primary Data. Collection of Secondary Data. Selection of an Appropriate Method for Data Collection. Types of Data Analysis. Statistics in Research. Measures of Central Tendency. Measures of Dispersion. Measures of Asymmetry (Skewness). Measures of Relationship. Simple Regression Analysis. Multiple Correlation and Regression. Procedure for Hypothesis Testing. Flow Diagram for Hypothesis Testing. Measuring the Power of a Hypothesis Test. Hypothesis Testing for Differences between Means. Hypothesis Testing for Comparing Two Related Samples. Interpretation and Report Writing: Meaning of Interpretation. Technique of Interpretation. Significance of Report Writing. Different Steps in Writing Report. Layout of the Research Report. Types of Reports. Oral Presentation. Mechanics of Writing a Research Report.

**Recommended Books:**

1. “Research Methodology” by C. R. Kothari.
2. “Practical Research” by Paul D. Leedy

Approval:

Board of Studies Res. No.1.1 Dated: 01.04.2022

Board of Faculty Res. No. 19.5 Dated:03.06.2022

ASRB Res. No. Dated:

Academic Council Res. No. Dated:

**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO**

**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION & COMMUNICATION TECHNOLOGIES**

Title of Subject : **Advanced Control System (IAC-651)**

Disciplines : Industrial Automation and Control

Term : 3rd

Effective : 23 batch & onwards

Pre-requisites : Linear Control Theory

Marks : Theory: 100 Practical: 00

Credit Hours : 3+0

Minimum Contact Hours : 42+0

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| Aims: | This course is designed to familiarize the students with the knowledge and understanding of advanced control system design and implementation. |
| Objectives: | After completion of this course, students would be able to:   * Model and linearize nonlinear systems, determine a suitable controller for the system and design a selected controller for the system * Contribute to development of advanced control applications. |

**Contents:**

Introduction to advanced control systems, SISO and MISO feedback design, Analysis and compensation of interactions in multivariable systems, multivariable control, stability of multivariable systems, System identification, linearization of nonlinear systems, cascade control systems, optimal state controller, State estimators, Design of state observers, neural network control systems, learning control system in neural networks, Fuzzy logic controllers, tuning of fuzzy logic controllers, adaptive fuzzy logic controllers, Kalman filter, Case studies.

**Recommended Books:**

1. S. Skogestad and I. Postlethwaite: Multivariable Feedback Control. Analysis and Design, Wiley, latest edition
2. R. C. dorf, “Modern Control Systems”, Eddison Wesley, Latest edition
3. Y. Sin and C. Xu, Intelligent Systems: Modeling, Optimization, and Control, CRC Press, Latest Edition.
4. Timothy J. Ross, “Fuzzy Logic with Engineering Application”, John Wiley & Sons, Latest edition.
5. Ogata, K,” Modern Control Engineering, Prentice Hall Inc., latest edition
6. Rolf Isermann.” Digital control systems”, Springer-verlag, London, latest edition
7. John Yen and Reza Langari. “Fuzzy Logic: Intelligence, Control, and Information”, Prentice Hall, latest edition

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