B Tech & M Tech Courses
in
Instrumentation Engineering

A Brief Account of the Subjects Covered

DEPARTMENT OF APPLIED PHYSICS

UNIVERSITY COLLEGE OF TECHNOLOGY

UNIVERSITY OF CALCUTTA

4 Year 8 Semester

B. Tech. in Instrumentation Engineering Course

[The 1st& 2nd Semester Courses that consist of some basic subjects are not covered here]

IE- 3rd SEMESTER

THEORETICAL PAPERS

301-PCCIE01: **Analog Electronics**

Module 1: Opto-electronic devices, **Module 2:** Transistor biasing circuits, **Module 3:** Linear Op-Amp Circuits, **Module 4:** Multivibrators

302-PCCIE02: **Digital Electronics**

Module 1: Number systems and codes, **Module 2:** Combinational Logic Design, **Module 3:** Examples of combinational logic design, **Module 4:** Sequential machine design, **Module 5:** Programmable Logic Devices, **Module 6:** Digital to Analog Converters

303-PCCIE03: **Electrical and Electronic Measuring Instruments**

Module 1: SI units, systematic and random errors in measurement, etc., **Module 2:** Measurement of resistance, **Module 3:** General features of electrical measuring instruments mechanism and dynamics, **Module 4:** DC and AC potentiometers, **Module 5:** Electronic Instruments, **Module 6:** Cathode Ray Oscilloscopes, **Module 7:** Digital instruments

304-BSC01: Engineering Mathematics – III

Module 1: Linear Algebra, **Module 2:** Probability and Statistics, **Module 3:** Calculus, **Module 4:** Differential Equations, **Module 5:** Analysis of Complex Variables, **Module 6:** Numerical Methods, **Module 7:** Laplace Transform

305-PCCIE04: Circuit Theory and Networks

Module 1: Introduction, **Module 2:** Sources, **Module 3:** Network analysis and theorems, **Module 4:** One-port and Two-port networks,

Module 5: Networks Graph and Topology, **Module 6:** Circuit Transients, **Module 7:** Filters: Module 8: Network Synthesis

PRACTICAL PAPERS

Analog Electronics Lab, Digital Electronics Lab, Network Theory Lab, Computation Lab

IE- 4th SEMESTER

THEORETICAL PAPERS

401-PCCIE09 Communication Systems

Module 1: Introduction to Communication Systems, **Module 2:** Analog Communication, **Module 3:** Digital Communication

402-PCCIE10 Sensors and Industrial Instruments

Module 1: Instrument transducers, **Module 2:** Principles of classical sensors and their applications, **Module 3:** Measurement of Pressure and Vacuum, **Module 4:** Torque measurement in rotating shafts. Vibration measurement using seismic accelerometers, Introduction to Smart sensors, **Module 5:** Instruments Transformers, **Module 6:** Hall effect and Hall drive, etc., Proximity sensors: Inductive, optical, magnetic, capacitive, ultrasonic.

403-PCCIE11 Control Systems

Module 1: Control system, **Module 2:** Standard test input signals, Time domain analysis and specification, steady state and transient response, static and dynamic error, **Module 3:** Concept of stability, **Module 4:** Design of lead, lag and lead-lag compensators, **Module 5:** Control system components, **Module 6:** State space analysis

404-PCCIE12 Microprocessors and Microcontrollers

Module 1: Introduction to Microprocessors, **Module 2:** Microprocessor Architecture, **Module 3:** Organization of the Intel 8085, **Module 4:** Instruction Set and Programming of the 8085, **Module 4:** Interfacing Memory and I/O Devices, **Module 5:** The 8085 Interrupt Systems, **Module 4:** Microcontroller – MCS-51 Family, **Module 5:** Timer/Counter: **Module 6:** Interfacing of MCS-51 with ADC, DAC, ZCD, etc.

405-OECIE01 Open Elective 1: One paper from the Open Elective Course List

PRACTICAL PAPERS:

Microprocessor Lab, Control System I Lab, Electrical and Electronic Measurement Lab, Sensor and Transducer Lab.

IE- 5th SEMESTER

THEORETICAL PAPERS

501-PECIE01 Professional Elective 1: One paper from the Professional Elective Course List.

502-PCCIE17 Digital Signal Processing

Module 1: Definition and classification of signals and systems, **Module 2 :** Analysis of systems, **Module 3 :** Analysis of signals, **Module 4:** Introduction to Digital Filters

503-PCCIE18 Process Control

Module 1: Process Characteristics, **Module 2:** Different control modes, **Module 3:** Control strategies, **Module 4:** Controllers, **Module 5:** Tuning of controllers, **Module 6:** Advanced control techniques, **Module 7:** Final control elements:

504-PCCIE19 Process Measurements

Module 1: Flow Measurement, **Module 2:** Temperature Measurement, **Module 3:** Measurement of level, **Module 4:** Measurement of Humidity and Moisture Content, **Module 5:** Density and Specific Gravity Measurement, **Module 6:** Measurement of viscosity and consistency, **Module 7:** Acoustical methods

505-PECIE02 Professional Elective 2: One paper from Professional Elective Course List.

506-HSMC01 Engineering Management

Module 1: Engineering Management, **Module 2:** Location of Factory, **Module 3:** Industrial relation, **Module 4:** Labour Turnover, Module 5: Production

PRACTICAL PAPERS: Communication Lab, Industrial Instrumentation Lab

IE- 6th SEMESTER

THEORETICAL PAPERS

601-Professional Elective 3: One paper from the Professional Elective Course List

602-Professional Elective 4: One paper from the Professional Elective Course List

603-Economics for Engineers

604-Open Elective 2: One paper from the Open Elective Course List

605-Open Elective 3: One paper from the Open Elective Course List

606-Open Elective 4: One paper from the Open Elective Course List

PRACTICAL PAPERS:

Digital Signal Processing Lab, Design Lab, Process Control Lab.

IE- 7th SEMESTER

PAPERS

701-Seminar: Technical Seminar on some engineering topics relevant to the course content.

702-Summer Internship

703-Project Ph-I

IE- 8th SEMESTER

801-Project Ph-II

802-General Viva Voce

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PROFESSIONAL ELECTIVE PAPERS (PEC)

PEC 01: Analytical and Biomedical Instrumentation

Module I: Gas Analysers, **Module 2:** Spectroscopic Analyzer, **Module 3:** Dissolved O2 and pH measurement, **Module 4:** Gas Chromatography, **Module 5:** Biomedical Instruments

PEC 02: Optical Sensors and Non-destructive Evaluation

Module 1: Optical Sensors, **Module 2:** Fiber Optic Sensors, **Module 3:** Non-Destructive Testing

PEC 03: Advanced Measurement and Automation Techniques

Module 1: Computer-based process control, **Module 2:** Programmable Logic Controller, **Module 3:** DCS, **Module 4:** SCADA

PEC 04: Transmitters, Recorders and Hazardous Area Instrumentation

Module 1: Basic requirement, general classification, etc., **Module 2:** Telemetry for current, voltage, frequency, position and impulse, fiber optic transmitter, smart transmitter: smart sensor, HART protocol, **Module 3:** Recorder, **Module 4:** Concept of safe area and hazardous area, Hazardous area classification, Protection techniques, etc., **Module 5:** Intrinsic safety, Classification of Intrinsic safety, etc.

PEC 05: Digital Communication

Module 1: Pulse Modulation-Sampling process, etc., **Module 2:** Baseband Pulse Transmission, etc., **Module 3:** Passband Data Transmission-Introduction, **Module 4:** Error Control Coding-Discrete memory-less channels – Linear block codes, etc., **Module 5:** Spread Spectrum Modulation- Pseudo- noise sequences, etc.

PEC 06: Process Plant Instrumentation

Module 1: Chemical plant instrumentation, **Module 2:** Power plant instrumentation, **Module 3:** Steel plant instrumentation

PEC 07: Non-Conventional Energy Sources

Module 1: Introduction to Energy Sources, etc., **Module 2:** Biomass as a Source of Energy, **Module 3:** Wind and tidal energy, **Module 4:** Solar Energy, **Module 5:** Direct energy conversion methods, **Module 6:** Fusion energy

PEC 08: Sensor Technology

Module 1: Sensors, **Module 2:** Sensor design and packaging, Techniques of crystal growing, etc., **Module 3:** Techniques of metal-semiconductor "plating" for developing sensors, **Module 4:** Single-chip electro-analytic sensor technology, photonic sensors, smart sensors in microelectronic systems, etc.

PEC 09: Biomedical Signal Processing and Analysis

Module 1: Objectives and difficulties in biomedical signal processing and analysis; etc., **Module 2:** Noise and artifacts in biosignals and its effect in diagnosis; Methods for noise elimination, etc., **Module 3:** Detection of events - Time domain analysis of biosignals, etc., **Module 4:** Diagnostic decision making

PEC 10: Advanced Control Engineering

Module 1: Digital control system, **Module 2:** Time response, Concept of Z-domain stability, etc., **Module 3:** State space analysis, **Module 4:** Concept of Controllability and Observability, etc., **Module 5:** Introduction to non-linear control, types of non-linearity, etc.

Open Elective Papers (OEC)

OEC01: Electrical machines

Module 1: Magnetic fields and magnetic circuits, **Module 2:** DC machine - motoring and generation, **Module 3:** Induction Machines, **Module 4:** Single-phase induction motors, **Module 5:** Transformers

OEC02: Soft Computing

Module 1: Introduction, **Module 2:** Fuzzy sets and Fuzzy logic systems, **Module 3:** Neural Network, **Module 4:** Genetic Algorithms, **Module 5:** Other Soft Computing techniques

OEC03: Mechatronics

Module 1: Introduction to Mechatronics and its Systems, etc., **Module 2:** Control Systems, open and close loop systems, etc., **Module 3:** Sensors and Transducers, **Module 4:** Pneumatic and Hydraulic Actuation Systems, **Module 5:** Robotics- Introduction, types of robots, etc.

OEC04: Computer Organization and Architecture

Module 1: Introduction to basic computer architecture, etc., **Module 2:** Microprogrammed control, control memory, etc., **Module 3:** Central Processing Unit, **Module 4:** Pipeline and Vector Processing, **Module 5:** Memory Organisation

OEC05: Database Management Systems

Module 1: Introduction, **Module 2:** Transaction Management, Decision Support Systems, etc., **Module 3:** Entity-Relationship Model, **Module 4:** Data Dictionary. Relational Algebra, Relational Calculus, SQL, etc., **Module 5:** User Interfaces and Tools, Forms and Graphical User Interfaces, etc., **Module 6:** Relational Database Design

OEC06: Power Electronics and Drives

Module 1: Power Semiconductor Devices, **Module 2:** Converters, **Module 3:** Inverters, **Module 4:** Chopper Circuits, **Module 5:** Introduction of Electrical drives, **Module 6:** DC motor drive, **Module 7:** Induction Motor Drive, **Module 8:** Traction Drive

OEC07: Introduction to Robotics

Module 1: Introduction, components, and structure of robotics system, **Module 2:** Kinematics of manipulators, rotation translation and transformation, etc., **Module 3:** Inverse Kinematics, **Module 4:** Robotic Motion, **Module 5:** Position Control

OEC08: Computer Networks

Module 1: Introduction, **Module 2:** Local Access Network Design, **Module 3:** LAN protocols-ALOHA protocols, etc., **Module 4:** Error Handling. Network Layer, **Module 5:** Transport Layer.

OEC09: Data Structure & Algorithms

Module 1: Overview of C language Time and Space Analysis of Algorithms - Order Notations, **Module 2:** Linear Data Structures - Sequential representations, etc., **Module 3:** Linear Data Structures, Link Representation, etc., **Module 4**: Recursion - Design of recursive algorithms, etc., **Module 5:** Non-linear Data Structure, Module 6: Radix Sort. File Structures, etc.

OEC10: Object Oriented Programming

Module 1: Object Oriented Programming Concept, **Module 2:** The Java Environment, **Module 3:** Extending Classes and Inheritance, **Module 4:** Array & String, **Module 5:** Package Organizing Classes and Interfaces in Packages, **Module 6:** Exception Handling

OEC 11: Data Analytics

Module 1: Data Definitions and Analysis Techniques Elements, **Module 2:** Descriptive Statistics, **Module 3:** Basic analysis techniques, **Module 4:** Data analysis techniques, **Module 5:** Case studies and projects.

2-Year 4-Semester

M. Tech. Degree in Instrumentation & Control Engineering Course

(with effect from the academic year 2024 - 2025)

[Note: There are two categories of students in the M Tech course of studies in Electrical Engineering. One is the M Tech Degree in Electrical Engineering for regular students preferably with a GATE qualification. The other is the M Tech degree in Electrical Engineering for Working Professionals. The latter one is a self-financed course for employed persons. The course curriculum for both streams is the same.]

SEMESTER I

Theoretical Paper

MIT11 Computational Methods

Module 1: Wavelet Techniques; **Module 2:** Fuzzy Sets; **Module 3:** Artificial Neural Network (ANN); **Module 4:** Introduction to random processes and stochastic systems.

MIT12 Modern Control Systems

Module 1: Review of classical feedback controls; **Module 2:** State Space; **Module 3:** Control Systems Analysis and Design in State Space; **Module 4:** Digital Control Systems and concepts of linear sampled data systems; **Module 5:** Introduction to Nonlinear Time-varying systems and linearization techniques.

MIT13 Biomedical Measurement and Instrumentation

Module 1: General Introduction to Biomedical Instrumentation and Action Potentials in Living Cells; **Module 2:** Electrodes and Their Models; **Module 3:** Electrophysiology of the Heart and cardiovascular system: ECG its measurement protocols and Instrumentation; **Module 4:** Measurement of Brain and muscle activities: EEG and EMG; **Module 5:** Safety in Biomedical Instrumentation and standards; **Module 6:** Measurement of blood flow and pressure, respiration, GSR; **Module 7:** Instrumentation in the clinical laboratory; **Module 8:** Biomedical imaging techniques.

MIT14 Elective Paper I [Anyone from the list]

PRACTICAL

MIP11 Advanced Control Lab

SEMESTER II

MIT21 Advanced Digital Signal Processing

Module 1: Z transform, Fourier Transform, Discrete Fourier Transform and applications; **Module 2:** Digital processing of continuous-time signals; **Module 3:** Digital filters: approximations, transformations, IIR and FIR filters, FIR filter design, window method, frequency sampling method; **Module 4:** Bilinear transformation method of coefficient calculation; **Module 5:** Analysis of finite word length effects in fixed point digital signal processing; **Module 6:** Introduction to adaptive filters and its applications, Stochastic process, FIR Weiner Filter, LMS algorithm, Convergence analysis, Introduction to optimal filter design; **Module 7:** Data adaptive methods for signal reconstruction and filtering – Wavelet and Empirical Mode Decomposition-based techniques and applications.

MIT22 Advanced Process Control

Module 1: Controller performance index, Model-based and model-free tuning and their comparative study, Advanced tuning techniques, and direct synthesis; **Module 2:** Model-based control, model uncertainty and disturbances, IMC structure and design, IMC based PI-PID controller design; **Module 3:** Introduction to multi-variable control systems, interaction analysis and multiple single loop design, design of multivariable controllers, relative gain array, tuning of MIMO systems, concept of de-coupler design; **Module 4:** Fuzzy control technique and its structure, Fuzzy control- real-time expert system design, Knowledge-based controller design, non-linear fuzzy control, Inferencing schemes, Rule base generation and rule minimization techniques; **Module 5:** Adaptive fuzzy control, Performance monitoring and evaluation, Adaptation mechanism; **Module 6:** Neural controller design, Neural-fuzzy controller with hybrid structure, Neural-fuzzy adaptive learning control network, structure learning of Neural-fuzzy controller; **Module 6:** Optimization techniques of Fuzzy and Neural-fuzzy controllers.

MIT23 Elective Paper II [Anyone from the list]

PRACTICAL

MIP21 Biomedical data acquisition and processing Lab

MIP22 Term Paper Leading Towards Thesis

SEMESTER III

MIP31 Mini project with Seminar presentation

MIP32 Project Phase I

SEMESTER IV

MIP41 Project Phase II

MIP42 General Viva Voce

ELECTIVE PAPER I

MIO 11 Advanced Engineering Mathematics

Module 1: Nonlinear differential equations: graphical and analytical methods of solutions; Perturbation and variation of parameter methods; Ritz and Galerkin method; Riccati, Vander Pol, Duffing-Mathieu equations; **Module 2:** Approximate solution of integral equations; **Module 3:** Nonlinear integral equation; **Module 4:** Operation research and quality control: Estimation of parameters, testing of hypothesis, decisions; **Module 5:** Quality control, acceptance, sampling, non-parametric tests; **Module 6:** Fourier Transform: Fourier integrals and its interpretation, Fourier transformation, Frequency spectrum, **Module 7:** Linear transformation of vector spaces; **Module 8:** Eigen values and eigen vectors, matrix polynomial; Cayley-Hamilton theorem and its application; **Module 9:** Canonical representations: Jordan and rational canonical form; bilinear, quadratic and Hermitian forms, positive and negative definite and semi definite form, Sylvester's criteria.

MIO12 Instrumentation and Measurement Techniques

Module 1: Measurement of displacement, velocity and acceleration: Variable Inductance and variable capacitance transducers; **Module 2:** Seismic accelerometers – piezoelectric and piezoresistive types; **Module 3:** Temperature sensing elements – RTD, thermistor, thermocouple, semiconductor IC sensors; **Module 4:** Pressure sensing elements – manometers, elastic elements, Bourdon tube, diaphragm, bellows, electrical type, McLeod gauge, Pirani gauge; **Module 5:** Flow sensing type – head meters (orifice, venturi), area meters, rotameters, electromagnetic flow meter, Coriolis flow meter,

Ultrasonic flow meter; **Module 6:** Smart Sensors, Introduction to Micro-electromechanical Systems (MEMS) , **Module 7:** Tomographic Techniques: Capacitance and Impedance; **Module 8:** Principles of Process control: process systems block diagram, transfer function, stability criteria. Types of control: Proportional, Proportional- Integral (PI), Proportional-Derivative (PD), PID; **Module 9:** Control elements: controller, final control elements; Wired signal transmission in industry (voltage 1-5V, current 4-20mA loop), F-V, V-F converters, V-I, I-V converters, A/D and D/A converters.

MIO13 PC-based Instruments

Module 1: PC-based DAS: functional structure and layout; **Module 2:** Signal conditioning fundamentals: amplification, single-ended or differential inputs, isolation, Noise reduction techniques: **Module 3:** Grounding, Shielding, Filtering, etc; **Module 4:** Principles of data acquisition in a PC: sampling concepts, A/D converters and their characteristics; **Module 5:** Bus protocols, PC expansion buses: ISA, EISA and PCI bus; Data acquisition using serial interfaces: RS-232,RS-422 and RS-485, USB;Plug-in data acquisition boards; **Module 6:** Introduction to Virtual Instrumentation, Graphical programming techniques, distributed VI; **Module 7:** Instrumentation buses: IEEE 488.1 and IEEE 488.2, PCMCIA, VXI, SCXI, PXI; **Module 8:** Introduction to NI LabVIEW: Functional blocks and capabilities; practical interfacing of real-life sensors with VI.

MIO14 Power Plant instrumentation

Module 1: Role of instrumentation, Instrument layout, Instrument schedule Instrument test pocket; **Module 2:** Desk panel layout. control room layout; **Module 3:** Burner management system auto control loops; **Module 4:** Drum level control, Mill air flow and outlet temperature control Superheated steam temperature control; **Module 5:** Instrument wiring diagram; **Module 6:** Transmitter grouping annunciation system; SCADA system; **Module 7:** Plant performance and outage.

MIO15 Process Automation

Module 1: Programmable logic controller, Distributed Control system; **Module 2:** Field control system, SCADA, Smart and Intelligent sensors, controllers and transmitters; **Module 3:** Types Of Communication Interface, Types Of Networking Channels, Parallel and serial communication Interface, Communication Mode, Synchronization and Timing; **Module 4:** Standard Interface, Software Protocol, ASCII Protocol, HART Protocol, Manufacturer Specific Protocol, Network Topology, Media Access Methods; **Module 5:** Open System Interconnection (OSI) Network Model, Device Bus and Process Bus Network; **Module 6:** Controller Area

Network (CAN), Devicenet, Controlnet, Ethernet, Proprietory Network, Smart Distributed System, Interbus – S, Seriplex Bit-Wide Device Bus Network, AS-I Interface, General Structure of an Automated Process.

MIO16 Artificial Intelligence and Robotics

Module 1: Problem-solving methods: Control strategies, Heuristic search, Reasoning, Breadth, depth, and best search; **Module 2:** Knowledge representation, Predicate Logic, Non-monotonic reasoning, statistical and probabilistic reasoning, Semantic nets, Conceptual dependency; **Module 3:** AI languages, Important characteristics. Expert system: structure, interaction with experts, Design examples; **Module 4:** Origin and types, Degree of freedom, Asimov's law, Dynamic stabilization; **Module 5:** Power sources, and sensors: Hydraulic, pneumatic, and electric drives, mechanical design, electrical speed control, path determination; **Module 6:** Machine vision, ranging, Manipulators, Actuators and Grippers: constructions, dynamics and force control. design consideration; **Module 7:** Kinematics and path planning, Solution of inverse kinematics problem; work envelop, hill climbing technique, Robot programming languages; Applications.

ELECTIVE PAPER II

MIO21 Advanced Control Systems

Module 1: Robust Control Systems; Nonlinear Control Systems Analysis and design; **Module 2:** Phase Plane Analysis; Describing Function Analysis (DF); **Module 3:** Frequency domain stability criteria, Popov's method and its extensions; Lyapunov Stability Analysis; **Module 4:** Adaptive control systems; Performance, Types of Adaptive Schemes, Linear parametric models, Adaptive laws, **Module 5:** Model reference adaptive control, Robustness in adaptive control, Adaptive control of nonlinear systems, Gain scheduling control; **Module 6:** Model Reference Adaptive System (MRAS), The MIT Rule, Block Diagram of an MRAS for adjustment of Feed Forward Gain based on MIT Rule. Adaptation Gain – Methods for determination. Design of MRAS using Lyapunov Theory; **Module 7:** Internal model principle-based control.

MIO22 Biomedical Signal Processing and Analysis

Module 1: Objectives and difficulties in biomedical signal processing and analysis; **Module 2:** Details of biomedical Signals - ECG, EEG and respiration signals and their spectral properties, Signal pattern in normal and different abnormal conditions; **Module 3:** Noise and artifacts in bio signals and its effect in diagnosis; **Module 4:** Methods for noise elimination by conventional filtering and adaptive techniques; Detection of events - Time domain analysis of bio-signals, Frequency domain analysis of bio-signals – Basics of

Fourier Transform, Wavelet Transform and their applications in bio-signal processing; **Module 5:** Diagnostic decision making – feature extraction, feature selection, classification techniques; **Module 6:** Introduction to analysis of non-stationary and multi-component signals.

MIO23 Precision Instruments and Standardization Practices

Module 1: Units; Standards; Standardizations and Technique; **Module 2:** Realization in standard laboratories, maintenance and reproduction, test and review. Modern techniques, and standards in different National Laboratories and Bureaus; **Module 3:** The fundamental constants and their classes and recent evaluation of the fundamental constant; **Module 4:** Standardization in Production Plants and manufacturing houses. Reliability Calibration; **Module 5:** Special types of CROs- analog storage, digital storage, sampling oscilloscope, mixed oscilloscope, spectrum analyser, harmonic distortion analyser, modulation analyser, arbitrary function generator; **Module 6:** Advance Bridge methods, Ratio Measurements, Inductive voltage divider, Ac and DC-current comparator, Voltage comparator, DC Current transformer, Low flux Measurements, saturable reactor techniques in measurements, **Module 7:** Magnetic modulator, Flux Gate Magnetometer.

MIO24 Hazardous Area and Control Room Instrumentation

Module 1: Concept of the safe area and hazardous area, Hazardous area classification, Protection techniques, Material classification; **Module 2:** Methods of explosion prevention-encapsulation; pressurization; purging; immersion; alarms and interlock, Explosion suppression system, Suppression techniques and suppression chemicals, Explosive actuated rupture disc, Deluge system; **Module 3:** Intrinsic safety, Classification of Intrinsic safety, Intrinsically safe loop, Safety barrier and their classifications; **Module 4:** Enclosure classifications, Fuses and Circuit breakers, Flame arrester, Conservation vents, Emergency vents, Desiccating vents, Fire and smoke detector, Flame scanner and Flame sensors; **Module 5:** Control room definition and location, Control room panel type and panel layout, Panel piping and tubing; **Module 6:** EM Interference, Shock hazard protection, Isolation, Different types of ground, Single point grounding, Multi-point grounding, Bonding, Filtering, Shielding, Cable laying and distribution; **Module 7:** Human engineering-Man-Machine interface system, Characteristics of man, Information capability, Priority settings,; **Module 8:** Power distribution, Battery backup, UPS, System redundancy.

MIO25 Pollution control and process plant instrumentation

Module 1: Identification of sources of pollution, the effect of pollution, sampling, measurement and analysis of pollutants in air, water, and soil, Control of pollution; **Module 2:** Instrumentation practice in process plant: functions, responsibility, economic considerations, wiring diagram, panel-based design consideration, and pollution control; **Module 3:** Instrumentation system for typical process industries: fertilizer, petrochemical, distillation, drying, food processing, pulp and paper.

MIO26 Machine Learning Techniques

Module 1: Basics of ML and brief history, AI, ML vs AI, ML vs Deep Learning, Types of ML; **Module 2:** General Steps of ML Supervised Learning; Classification: Random Forest, Decision Trees, Logistic Regression, Support Vector Machines, KNN, Naïve Bayes; **Module 3:** Regression: Linear Regression, Regularization Techniques, Polynomial Regression; Unsupervised Learning; Clustering: K-Means, K Nearest Neighbours, Association Rule Learning; Dimensionality Reduction: PCA, SVD; **Module 4:** Reinforcement Learning: Markov Decision, Monte Carlo Prediction; **Module 5:** Neural Networks/Deep Learning: CNN, RNN/LSTM/GRU, Transfer Learning; Predictive Analytics - Forecasting: Logistic, Time Series (ARIMA), Case Study (Time Series); Ensemble Techniques: Boosting, Bagging.