SYLLABUS OF MASTER OF TECHNOLOGY IN
INSTRUMENTATION AND ELECTRONICS ENGINEERING

First Semester

Category: Departmental / Specialization Basket

PAPER-I

PG / IEE / T / 111A - Measurement System Design

PG / IEE / T / 111B - Process Control System Design/ Synthesis

PG / IEE / T / 111C - Embedded Systems

PAPER-II

PG / IEE / T/ 112A - Signals and Systems
System representation: Discrete time systems, General definition of a system, SISO & MIMO systems, Math model, State space representation, State-variable model, LTI state equations. Signal Characterization: Deterministic & random signals, General form,

PG / IEE / T/ 112B - Computer Simulation in Modeling and Analysis
Nature of simulation; Systems, Models and simulation; Discrete-event simulation; Simulation of queuing and inventory systems; Modeling complex systems; Simulation languages - GPSS-V and SLAM; Comparison with general purpose languages; Selection of input probability distribution; Random number and random variety generators; Output data analysis; Validation of simulation models.

PG / IEE / T/ 112C- Digital Communication System

PAPER-III

PG / IEE / T/ 113A - Advanced Electronic Instrumentation
PG / IEE / T/ 113B - Digital Systems Design with FPGAs
Hierarchy in Design, Controllers, Mealy and Moore Machines, metastability, synchronization, FSM issues, clock trees, clock skew, pipelining, multiple clock domains, case studies. VHDL: behavioral, data flow, structural models, simulation cycles, process, concurrent and sequential statements, loops, delay models, synthesis, FSM coding, library, packages, functions, procedures, resource sharing, test benches, hardware-software cosimulation, bus function models. FPGA: logic block architecture, routing architecture, programmable interconnections, design flow, Xilinx, Vertex and Actel ProASIC architectures, device programming, debugging, applications, case study, embedded system on programmable chips.

PG / IEE / T/ 113C - Medical Instrumentation

Category: Inter-Disciplinary Basket

PAPER-IV

PG / IEE / T/ 114A- Soft Computing- Theory and Application

PG / IEE / T/ 114B- Non-Destructive Testing
Surface feature inspection and testing: General, Visual, Chemical, and Mechanical. Optical - laser probe, holography, and ultrasonic surface wave probing, Magnetic -
magnetization, flux, and Electro potential, Electrical resistivity, Electromagnetic - eddy current techniques, Penetrant, Radiation backscatter, etc.
Sub - surface (Internal feature inspection and Testing: Thermal - temperature sensing, Electrical resistivity, ultrasonic - longitudinal and shear wave methods, acoustic emission methods, X rays - refraction / diffraction and fluorescence, Gamma rays - radiography. IQI (image quality indicator), Xerography, Image intensification methods, Electron microscopic techniques. ISO specifications and other certifications.

Alternatively, any one subject from the inter-disciplinary basket of ETCE Department.

PAPER-V

PG / IEE / T/ 115A- Calibration and Standardization Practices

PG / IEE / T/ 115B- Instrumentation and Measurement Techniques
1. General measurement systems: specifications of instruments, their static and dynamic characteristics
2. Transducers: sensing elements and measurements:
   A. Transducers:
      Resistance type - potentiometer, strain gauge;
      Inductive type – LVDT
   B. Sensing elements:
      Temperature sensing elements – RTD, thermistor, thermocouple, semiconductor IC sensors;
      Pressure sensing elements – manometers, elastic elements, Bourdon tube, diaphragm, bellows, electrical type, McLeod gauge, Pirani gauge;
      Flow sensing type – head meters (orifice, venturi), area meters, rotameters, electromagnetic flowmeter, Coriolis flow meter, Ultrasonic flowmeter;
      Analytical sensors – pH measurement
   C. Measurement circuits:
      Deflection bridge, Instrumentation amplifier
3. Principles of Process control:
   A. Process control: process systems block diagram, transfer function, stability criteria
B. Types of control: Proportional, Proportional-Integral (PI), Proportional-Derivative (PD), PID
C. Control elements: controller, final control elements, control systems
D. Introduction to PLC and DCS
4. Signal Conditioning:
   Switching devices – relays (electromagnetic), contactor, transistor switches
   Opamp – inverting, non-inverting, differential configurations
   Power amplification, active filters (LP, HP, BP and Notch), constant current and voltage sources.
   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.

PG / IEE / T/ 115C- Aerospace Instrumentation
Measurement of atmospheric density and conductivity, balloons and payloads, electrostatic flux meter. Measurement of pollutants by laser optical method, measurement of NO and ozone, ion density measurement, measurement of stratospheric aerosols, instruments in upper atmosphere studies, measurement using rockets & satellites, measurement of X-ray & X-ray fluxes, optical remote sensing.
Aircraft instrumentation, measurement of aircraft speed, measurement of fluid velocity, local linear velocity & bulk velocity strain and thrust measurement, acceleration, aircraft rocket-study instrumentation, missile control instrumentation, instrumentation in space research.

PAPER-VI

PG / IEE / T / 116A- Mathematical Methods in Instrumentation
Series: Infinite series, Power series; Review of linear ordinary (integer order) differential equations; Fractional order differential equations; Linear systems: Qualitative behaviour; Stability studies; Study of equilibria: Another approach; Nonlinear vis-a-vis linear systems; Stability aspects: Liapunov's direct method; Manifolds: Introduction and applications in nonlinearity studies; Periodicity: Orbits, limit cycles, Poincare map; Bifurcations; Catastrophes; Dynamical systems

PG / IEE / T / 116B- Optimization Techniques

PG / IEE / T / 116C- Electro-Optics and Optoelectronics

Category: Sessional Courses

SESSIONAL 1

PG / IEE / S / 111- Laboratory
Each student has to be proficient in the usage of certain software tools like MATLAB, PSpice, LABVIEW etc. for use in system modeling, testing and specific instrumentation applications.

SESSIONAL 2

PG / IEE / S / 112- Assignment

Second Semester

Category: Departmental / Specialization Basket

PAPER-VII

PG / IEE / T/ 127A- Instrumental Analysis
and Electro chromatography. Electron Microscopy - SEM with auxiliary equipment like AUGER. Electrochemical cells, cell potentials, electrode potentials, Reference electrodes, Metallic electrodes, Membrane electrodes, Potentiometric methods.

**PG / IEE / T/ 127B - Sensors- Science and Technology**
Principles of Physical and Chemical Sensors: Sensor classification, Sensing mechanism of Mechanical, Electrical, Thermal, Magnetic, Optical, Chemical and Biological Sensors. 
Sensor Characterisation and Calibration: Study of Static and Dynamic Characteristics, Sensor reliability, aging test, failure mechanisms and their evaluation and stability study. 
Sensor Modeling: Numerical modeling techniques, Model equations, Different effects on modeling (Mechanical, Electrical, Thermal, Magnetic, Optical, Chemical and Biological) and examples of modeling. 
Sensor Interfaces: Signal processing, Multi sensor signal processing, Smart Sensors, Interface Systems. 
Sensor Applications: Process Engineering, Medical Diagnostic and Patient monitoring, Environmental monitoring etc

**PG / IEE / T/ 127C- Control of Industrial Process**
Basics of process control systems, process instrumentation diagram for different process control loops. 
Instrumentation system design for different units:- 
- Deaerator of power plant 
- Safety Interlock instrumentation system of a turbine driven boiler feed water pump. 
- Control of Distillation Column 
- Control of Furnace 
Studies of different Units related to process plant: Annunciator, Transmitter 
Comparative study of PLC, DCS and SCADA.

**PAPER-VIII**

**PG / IEE / T/ 128A - Speech Processing**
Introduction to speech processing - its necessity. Digital models for speech signals: process of speech production, acoustic theory of speech production, and models of speech production, auditory knowledge. Digital representation of speech waveform: sampling speech signals, quantization, delta modulation, differential PCM, code conversion, other new methods of coding. Fundamentals of speech analysis: background of speech processing tools, spectrographic analysis, short time analysis, time frequency analysis,

**PG / IEE / T/ 128B - Digital filtering and Control**

**PG / IEE / T/ 128C - Pattern Recognition**

**PG / IEE / T/ 128D - Advanced Microprocessors and Microcontrollers**

**PAPER-IX**

**PG / IEE / T/ 129A- MEMS Sensors and Actuators**
Design: Methodology of MEMS Design- Flow chart. Components – Modelling, Design, Fabrication, packaging, material characterization VLSI technology used in Micro-sensor system. Application:
Sensors: Inertial sensors, acoustic devices, RF MEMS, pressure sensors, chemical sensors, biochemical sensors.
Actuators: Electrostatic, thermal, electromechanical, others.

**PG / IEE / T/ 129B- Electronic System Design**

**PG / IEE / T/ 129C- Electronic Olfaction**

**Category: Inter-Disciplinary Basket**

**PAPER-X**

**PG / IEE / T/ 1210A- Dynamic System Control and Optimization**
Mathematical descriptions of linear systems- input-output and state space descriptions

**PG / IEE / T/ 1210B - Control System Synthesis**
A. Principles of Statistical Design:
Power density spectra of system outputs, mean square error minimization, optimum system in time domain; optimization/minimization in servo problems, Saturation control, Nonlinear Systems.

B. Nonlinear Systems:
   a. Describing Function: System design using describing function techniques, limitations and disadvantages, accuracy analysis.

C. Digital Control:
   a. Discretization - requirement, principles and methods.
   b. Design Methods - Root locus, frequency response etc., their limitations; Different approaches of digital controller design - by transformation of continuous time model to z-domain, by direct digital modelling, by discrete approximation, by transformation to w-domain. Algorithm design - direct method, parallel method, factorization method; General Design considerations, Comparison of algorithms.


E. Large Scale Systems: System decomposition, Hierarchical, Multilevel Control and their co-ordination.

F. Control designs using distributed computer network.

**PG / IEE / T/ 1210C - Environmental Instrumentation**

**PG / IEE / T/ 1210D- Applied Fractional Order Systems**
Mathematical Basis: Definition of Fractional Order Differential Equation (FODE) and Fractional Order Integration Equation (FOIE), difference between FODE and Integer order differential equation, computational difficulties in FODE and FOIE, effect of initial conditions. Developing efficient numerical tools. Fractional Order systems in physical world: Mechanical systems- visco-elastic, thermal; Chemical systems- diffusion, corrosion, micro-porous; Electrical systems -magnetic, dielectric relaxation; Application of Fractional Order Systems: Modeling of physical systems, Fractional PID controller design, Optimal Controller design, Signal processing.

**Category: Sessional Courses**
SESSIONAL 1
PG / IEE / S / 121- Term paper leading to thesis

SESSIONAL 2
PG / IEE / S / 122- Seminar

Third and Fourth Semester
Category: Sessional Courses

SESSIONAL 1
PG / IEE / TH / 21- Thesis Work

SESSIONAL 2
PG / IEE / VV / 22- Viva-Voce