

# INSTRUMENTATION ENGINEERING

## Programme Structure

Course Code	Course Title	Lecture (L) Hours Per Week	Tutorial (T) Hours Per Week	Practical (P) Hours Per Week	Total Credits
ECE2351	Basic Instrumentation	3	-	-	3
ECE2451	Virtual Instrumentation	3	-	-	3
ECE2551	Biomedical Instrumentation	3	-	-	3
ECE2651	Analytical Instrumentation	3	-	-	3
ECE2751	Industrial Process Control	3	-	-	3
ECE2851	Project (Instrumentation Engineering)	3	-	-	3
	<b>TOTAL</b>				<b>18</b>

# INSTRUMENTATION ENGINEERING

## Syllabus

### BASIC INSTRUMENTATION

Course Code: ECE2351

Credit Units: 03

#### Introduction

Review of measurement and measuring systems. Functional elements of a measuring system. Input-output configuration of instrumentation systems. Methods of correction for interfering and modifying inputs. Errors and uncertainty in measurements, Statistical analysis of errors. Loading effects, Generalised impedance and stiffness.

#### Generalized Performance Characteristics

Static and Dynamic performance characteristics, Characteristic of periodic and transient inputs and the response of measuring system to these inputs. Response of measuring system to random inputs, Frequency spectra, auto correlation, cross correlation spectral density, Experimental determination of system parameters, requirement of instrument transfer function to ensure accurate measurement.

#### Measurement System

Introduction, principle, design of various active and passive transducers. Introduction to semiconductor sensors and its applications, design of signal conditioning circuits for various Resistive, Capacitive and Inductive transducers and piezoelectric transducer, Analog to Digital and Digital to Analog converters, modulation – types, filters – active, passive, digital, Data transmission and telemetry-classification, Recorders – Types of recorders, XY-Plotters, Ultraviolet, magnetic and digital recording.

#### Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

#### LABORATORY/FIELD EXPERIENCES

1. Experimental determination of system parameters.
2. Study and verification of transducer characteristics.
3. Study of signal conditioning techniques.
4. Verification of dynamic performance characteristics of a given system.
5. Case study of a real life measuring system in an industry.
6. Various data acquisition software.

#### BOOKS RECOMMENDED

- Measurement System, Applications, and Design, E.O. Doebelin. McGraw-Hill International.
- Introduction to Instrumentation & Control, A.K Ghosh, Prentice Hall of India.
- Principles of Measurement and Instrumentation, Alan S Morris, Prentice Hall of India
- Transducers and Instrumentation, DVS Murthy, Prentice Hall of India
- Electrical and Electronics Measurement and instrumentation, A.K. Sawhney, Dhanpat Rai & Sons. Delhi

# VIRTUAL INSTRUMENTATION

Course Code: ECE2451

Credit Units: 03

## Course Contents:

**Introduction to Virtual Instrumentation:** Introduction, Historical perspective, advantages, block diagram and architecture of a virtual instrument, conventional vs. virtual instrumentation.

**Introduction to Software :** Introduction to Lab VIEW, Front panel, back panel representations, Block diagram, Menus, Palettes, VI and Sub VI, Editing and Debugging VI, Structures, Arrays, Clusters, Charts and Graphs, Data acquisition, Instrument Control, Signal Generation and Signal Processing Examples

**Introduction to systems hardware:** ADC, DAC, D/O, counters and timer, PC hardware structure, timing, interrupts, DMA, software and hardware installation, Configuring data acquisition hardware using the drives in application software, use of DAQ library functions for different analog and digital input/output operations. Input/output devices & functions like data gloves, joysticks, CRT etc.

**Application of Virtual Instrumentation in various fields:** Aviation, Automotive, High Voltage, Defense, Chemical, Industrial, Marine, Medical, Mining, Nuclear Energy, Virtual landscapes.

## Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

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## LABORATORY / FIELD EXPERIENCES

1. Geographical programming using Lab VIEW
2. Applications of Lab VIEW

## BOOKS RECOMMENDED

- Learning with LabVIEW 7 Express – R.H. Bishop, Pearson Education, Delhi.
- LabVIEW Basic 1 Course Manual, National Instruments
- Virtual Instrumentation Using LabVIEW- Sanjay Gupta & Joseph John, TMG; 2005.
- LabVIEW for everyone -Wells Lisa K and Travis Jeffrey, Prentice Hall.

# BIOMEDICAL INSTRUMENTATION

Course Code: ECE2551

Credit Units: 03

## Course Contents:

### Sensors and Transducers for biological applications

Types, properties, characteristics and selection of transducers for biological instrumentation.

### Measurement of electrical parameters

Leads and electrodes, electrocardiography, electrical activity of the heart, equivalent cardiac generator. Einthoven lead system, standardization of recording and display of ECT (Electrocardiogram), EEG (Electroencephalogram), EMG (Electromyogram), EOG (Electrooculogram), ERG (Electroretinogram), EGG (Electrogastogram).

### Measurement of non-electrical parameters

Blood flow, drop recorder, electromagnetic flow meter, measurement of systolic and diastolic pressures, blood pressure instruments, intraocular pressure, lung air pressure, Audiometers. Measurement of body temperature, thermography. Cardiac tachometer, respiration rate phonocardiogram, heart sounds electrical stethoscope pulmonary function analysers. CO<sub>2</sub> - O<sub>2</sub> - Concentration in exhaled air, blood and lungs, pH value of blood, impedance plethysmography blood gas analysers, blood cell counters.

### Medical Imaging Systems

Medical display systems, medical thermography X-Ray, diathermy equipment. Ultrasonics in biomedical application for diagnostic and therapeutic, CAT, MRI, Laser applications in biomedical field.

### Patient safety

Electrical Safety of Medical Equipments, Shock Hazards from Electrical Equipment, Methods of Accident Prevention, Test Instruments for checking Safety parameters of biomedical equipments.

### Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

### BOOKS RECOMMENDED

- Biomedical Instrumentation and Measurements; L.C. Cronwell F.J. Weibell. E.A. Pfeiffer, PHI.
- Principles of applied instrumentation: Gaddes and Baker, John Wiley & Sons.
- Handbook of Bio-medical Instrumentation; R.S. Khandpur, McGraw Hill
- Medical Instrumentation – Application & Design, John G. Webster, Editor, John Wiley & Sons.

# ANALYTICAL INSTRUMENTATION

Course Code: ECE2651

Credit Units: 03

## Course Contents:

### Analytical Methods of Measurements

Physical methods of chemical analysis, special methods of analysis, basic techniques, terminologies, units, Interaction of electromagnetic radiations with matter, emission, absorption and scattering techniques. Instrumentation related to X-Ray, Ultraviolet and Infrared techniques.

### Special Analysis

Various light sources, spectrometer, detectors and data processing, comparison of various spectral analytical techniques, refractometry, nuclear magnetic resonance spectrometry. Analytical techniques based on separation method: Basics of chromatography liquid, gas and HPLC Mass Spectrometry and related instrumentation.

### Electrometric Methods of Analysis

Techniques and related instrumentations for pH and selective potentiometry, Voltametry, Colometry and Conductometry, Analytical data presentation. Error analysis, Design considerations of an analytical laboratory, automated analysis, Atomic absorption, spectrometry, polarometry, Turbidimetry, Nephelometry.

## Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

## BOOKS RECOMMENDED

- Instrumental Methods of Chemical analysis; Galen W. Ewing, McGraw-Hill, Koga Kusa Ltd.
- Instrumental Methods of Analysis: HW Willard, LynnelMerrikt. Jr John A. Dean, F.A. Settle, Jr. Wadsworth Publishing Co. U.S.A.
- Introduction to Instrumentation Analysis: Robert D.Braun McGraw Hill Co. International Ed.
- Analytical Instrumentation HandBook: Galen W.Ewing, Marcel Decker Inc, USA.
- Instrumental Methods of Chemical Analysis: GurdeepChetwal, Sham Anand Himalaya Publishing House.
- Instrumental Methods of Chemical Analysis: B.K. Sharma, Goel Publishing House, Meerut.
- Instrumentation Engineers Hand Book-Process Control, BG Liptak, Butterworth Heinemann.

# INDUSTRIAL PROCESS CONTROL

**Course Code: ECE2751**

**Credit Units: 03**

## **Course Contents:**

**Process Characteristics:** Process, Process variable, mathematical modeling of liquid, gas, thermal, mechanical and chemical system. Linearizing techniques, liquid level control in a tank. Dynamics of manometer, response of non-interacting and interacting first order elements in series.

**Controller characteristics:** Characteristics of on-off, proportional, integral, derivative modes and their combinations.

**Automatic control:** Single and combined modes in closed loop, static error, velocity error. Dynamic behavior of feedback control processes for different modes. IAE, ISE, IATE criteria. Tuning of controllers.

**Controllers:** Electronics, pneumatic, hydraulic controllers implementing. Single and composite mode of controllers. Latest trends in industrial controllers employing PLCs & other logic devices such as fuzzy logic control DCS & Computer based systems etc.

## **Final control elements:**

Types & function of Control valves. Electrical, Pneumatic, hydraulic actuators.

## **Examination Scheme:**

<b>Components</b>	<b>A</b>	<b>CT</b>	<b>S/V/Q</b>	<b>HA</b>	<b>EE</b>
<b>Weightage (%)</b>	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

## **Books recommended:**

- Instrument Engineers' Handbook of Process Control; Bela G. Liptak; 3rd Edn. Chilton Book Company Randor Pennsylvania
- Process Control Instrumentation Technology; CD Johnson 8th Edn; PHI 2006
- Automatic Process Control; D.P.Eckman; 1992 Wiley Eastern Ltd.
- Industrial Instrumentation; D.P. Eckman; Wiley Eastern Ltd.
- Principles of Industrial Process Control; D.P.Eckman;Wiley Eastern Ltd.
- Process System analysis & control; D.R.Coughanowr; 2<sup>nd</sup>Edn; 1991;McGraw International Edn.
- Principles of Process Control; D. Patranabis; 2<sup>nd</sup> Edn.1998 TMH
- Process Control; Peter Harriot; 2000, TMH
- Chemical Process Control; G. Stephanopoulos; 2002; PHI