**Approved in 45th BoA Meeting (18-02-2022)**

**Course number** : **IC231**
**Course Name** : **Measurement and Instrumentation**
**Credit Distribution** : **2-*0*-*2*-*3***
**Intended for** : **All the B.Tech branches**
**Prerequisite** : IC152 Data Science I/Computer and Data Science, IC161 Applied Electronics, IC161P Applied Electronics Practicum
**Mutual Exclusion** : **None.**

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## 1. Preamble:

The objective of the course is to provide an overview of measurement and instrumentation techniques used in engineering disciplines viz. mechanical, chemical, electrical, electronics, etc.

Upon completion of this course, the students will be able to

1. ***Identify*** and ***differentiate*** between different classes of sensors and actuators and choose the right component for application-specific purposes.
2. ***Use*** commonly used open-source microcontroller and microcomputer platforms for signal generation, sensor data acquisition, device actuation and automation.
3. ***Analyze*** and ***compare*** design approaches and architectures of real-world measurement systems, and identify key parameters for assessing their performance.
4. ***Design*** open and closed loop actuation, automation and measurement systems for their own discipline specific applications.

## 2. Course Modules with quantitative lecture hours:

**Topic 1: Measurement fundamentals** – Fundamental and derived quantities: static and dynamic, understanding, sensitivity, stability, resolution, accuracy, precision, calibration, and types of errors. (2 Hours)

**Topic 2:** Microcontroller and microcomputer-based data acquisition and automation – Introduction to microcontroller and microcomputer (e.g., Arduino, Raspberry Pi), interfacing considerations (e.g., communication protocols, use of multiplexers), device control and data acquisition using Python, simple routines for signal processing and analysis examples. (4 Hours)

**Topic 3: Principles of Instrumentation** – Sensor interrogation principles - e.g., using bridge circuits, signal amplification, signal conditioning (transduction, linearization), phase measurements, active and passive filters, isolation and shielding, elements of control theory, digital data acquisition principles using ADC/DACs. (6 Hours)

**Topic 4: Sensors and Actuators** – Sensor classification, static and dynamic characteristics, Sensor examples from different domains – mechanics (e.g., strain gauge, accelerometer, LVDT), thermodynamics (e.g., thermistors, thermocouples), fluidics (e.g.,

venturimeter, ultrasonic flowmeter), biomedical (e.g., electrodes), electromagnetics (e.g., Hall sensor). Actuator examples – piezo-electric transducer, stepper motor. (10 Hours)

**Topic 5: Measurement System Examples** – Systems approach to design, Noise and SNR considerations (e.g. application of Friis equation), Analysis of design of real-world measurement systems – for e.g. structural health monitoring, biomedical systems (e.g. ECG, EMG, EEG), air-quality monitoring using electrochemical sensors, LIDAR, contact-based (e.g LVDT) and non-contact (e.g. ultrasonic, optical) distance measurement systems (6 Hours)

**Laboratory/practical/tutorial Modules: (28 hours)**

1. Stepper motor controller
2. Temperature measurement using thermal sensors,
3. Flow measurement,
4. Experiment on LVDT,
5. Level/distance measurement using contact-less sensor,
6. Vibration/Sound measurement and FFT based analysis,
7. Chemical composition detection,
8. Bio-signal measurement,
9. Project.

## 3. Text books:


1. Fraden, Jacob. "Handbook of modern sensors." Springer Science+Business Media, 2010.
2. Khandpur, R, "Handbook of Biomedical Instrumentation." 3/e, Tata McGraw Hill, 2014.


## 4. References:


1. Doeblin, E. O., Manik, D. N., "Measurement Systems", 6/e, Tata McGraw Hill India, 2011.
2. Singh, S. K., "Industrial Measurement and Control", 2/e, Tata McGraw Hill India, 2003.
3. Webb, A. G., "Principles of Biomedical Instrumentation", Cambridge University Press UK, 2018.


## 5. Similarity with the existing courses:

**(Similarity content is declared as per the number of lecture hours on similar topics)**

| S. No. | | Course Code | Similarity Content | Approx. % of Content |
|---|---|---|---|---|
| 1. | Applied Electronics | IC161 | Sensors and Actuators | 10% |
| 2. | Measurement and Instrumentation | EE313 (Discipline Elective) | Fundamentals, Strain gauge, accelerometer thermocouples, bridge circuit | 15% |

**6. Justification of new course proposal if cumulative similarity content is >30%: NA**