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| Course No | Course Name | L-T-P-Credits |
| **EE 206** | **Measurement & Instrumentation** | **3-0-0: 3** |
|  Prerequisite: nil  |
| **Course Objectives**:1. To understand the use various measuring electronics instruments and measurement

methods in electronic systems 1. Development of the skills to define measurement parameters, standards, characteristics, errors.
2. To build up the knowledge about the dynamics, operation, characteristics and use of various types of analog as well as digital instruments for a given applications.

**Course Outcomes:**1. Ability to understand the basic knowledge about the measurement of various electrical parameters (with accuracy, precision and resolution), measurement systems, methods, standards, characteristics, errors and should understand the types of applications of the measuring Instruments.

 1. Ability to know the importance of AC and DC bridges for accurate measurement of various relevant electrical parameters (Resistance, Inductance, Capacitance, Loss factor). Students should be able to find the application of these circuits in communication systems and complex electronic circuits.
2. Ability to understand the necessity, principle of operation, sources of error, range extension of different indicating and integrating instruments for the measurement of DC or AC current or voltage.
3. Ability to identify the necessity and utilization of instrument transformer in the protection circuits of power system for the operation of over current and under voltages.
4. Ability to gain knowledge on utilization and interpretation of various transducers along with practical implementation.
5. Ability to use various analog and digital measuring electronics instruments and measurement methods in electronic systems.
6. Ability to understand the basic concepts of general purpose oscilloscopes, DSO and recorders. Students should be able to measure different parameters such as voltage, frequency and phase angle of signal using CRO.
7. Ability to understand the basics of data acquisition process.
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|  **SYLLABUS** |
| **Module** | **Contents** | **Hours** |
| I | **Performance Characteristics of Measurement Systems**:Basics of Measurements: Accuracy, Precision, resolution, reliability, repeatability, validity, standards and calibration; noise, signal to noise ratio, errors in measurement. Input-output configuration of instruments and measurement systems. Static characteristic of measuring devices; Dynamic characteristics of instrumentation systems. | 03 |
| II | **Measurement of Resistance, Inductance and Capacitance:**Bridge Measurement: DC bridges- wheatstone bridge. AC bridges-Kelvin’s double bridge, Maxwell, Anderson, De-Sauty, Wien bridge, Schering bridge networks. Wagner earthling device. | 08 |
| III | **Indicating and Integrating Instruments:** Construction and principle of operations of moving coil, electrodynamometer, moving iron, and Electrostatic type indicating instruments. Extension of instrument ranges using shunt, multipliers. Principle of operation of the thermoelectric and rectifier type instruments. | 10 |
| IV | **Instrument Transformers and Transducers** Theory of current and voltage transformer, ratio error and phase angle, burden, turns compensation performance characteristics, testing and applications of CT and PT. Resistive, Inductive and Capacitive transducers, Piezoelectric transducer, photoelectric transducer and basic signal conditioning circuits for transducers.  | 08 |
| V | **Analog & Digital Instruments:**Electronic Instruments for Measuring Basic Parameters: Amplified DC meter, AC Voltmeter; True- RMS responding Voltmeter; Digital voltmeter and multimeter, Q-meter Voltmeter. CRO: operation; measurement of voltage, frequency and phase angle; Digital Storage Oscilloscope; Digital data Acquisition Systems.Digital display and recording devices: Bar graph display: seven segment and dot matrix display; signal recorders: XY recorders, digital recording and data loggers. | 07 |

**Essential Readings:**

1. A. K. Sawhney, “A course in Electrical & Electronic Measurements & Instruments”, Dhanpat Rai and Co. Pvt. Ltd., 2015
2. A. D. Heltrick & W.D. Cooper, “Modern Electronic Instrumentation & Measuring Instruments” PHI, 1992
3. A. J. Bouwels, “Digital Instrumentation”, McGraw Hill, 1986.

**Supplementary Readings:**

1. D Patranabis, “Principle of Industrial Instrumentation”, TMH, 2nd Edition, 2008
2. H. S. Kalsi, “Electronic Instrumentation” Tata McGraw Hill, 3rd Edition, 2010.
3. Ernest O. Doebelin, “Measurement systems”, Tata-McGraw Hill, 6th Edition, 2011
4. David A Bell, “Electronic Instrumentation and measurement”, OUP, 3rd Edition, 2013
5. C. S. Rangan, Sharma, “Instrumentation – Devices & Systems” TMH, 2nd Edition, 2017