COURSE CONTENT

ELECTRICAL MEASUREMENTS AND SENSORS								
II Semester: EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
2540226	**Core**	3	0	0	3	40	60	100
Contact Classes:45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:45**		
Prerequisites: **Electrical Circuits-I & II, Analog Electronics and Electromagnetic Fields.**								

Course Overview:

This course introduces electrical measurements and instrumentation, covering measuring instruments, power and energy measurement, bridges, sensors, and smart metering systems. It builds the fundamentals required for accurate measurement and monitoring in electrical and industrial applications.

Course Objectives:

1. To understand the working principles of various analog measuring instruments and their torque mechanisms.
2. To learn the operation and applications of potentiometers and instrument transformers for accurate measurements.
3. To analyze the methods of measuring electrical power and energy using different types of meters.
4. To evaluate the performance of DC and AC bridges for measuring resistance, inductance, and capacitance.
5. To explore various sensors and smart instrument technologies used in modern measurement systems.

Course Outcomes: After Completion of the Course, Students should be able to

1. Explain the operation and torque mechanisms of analog measuring instruments.
2. Describe the principles and applications of potentiometers and instrument transformers.
3. Apply methods for measuring electrical power and energy using wattmeter and energy meter.
4. Compare different bridge circuits used for measuring resistance, inductance, and capacitance.
5. Identify various sensors and smart instrument systems used in modern measurement applications.

UNIT - I: Introduction to Measuring Instruments: Classification – deflecting, control and damping torques – Ammeters and Voltmeters – PMMC, moving iron type instruments – expression for the deflecting torque and control torque – Errors and compensations, extension of range using shunts and series resistance. Electrostatic Voltmeters-electrometer type and attracted disc type – extension of range of Electrostatic Voltmeters.

UNIT - II: Potentiometers & Instrument Transformers: Principle and operation of DC Crompton's potentiometer – standardization – Measurement of unknown resistance, current, voltage. AC Potentiometers: polar and coordinate type's standardization – applications. CT and PT – Ratio and phase angle errors (Qualitative approach).

UNIT - III: Measurement of Power & Energy: Single phase dynamometer wattmeter, LPF and UPF, Double element and three element dynamometer wattmeter, expression for deflecting and control torques – Extension of range of wattmeter using instrument transformers – Measurement of active and reactive powers in balanced and unbalanced systems. Single phase induction type energy meter – driving and braking torques – errors and compensations – testing by phantom loading using RSS meter. Three phase energy meter – trivector meter, maximum demand meters and net metering.

UNIT - IV: DC & AC Bridges: Method of measuring low, medium and high resistance – sensitivity of Wheat-stone's bridge – Kelvin's double bridge for measuring low resistance, measurement of high resistance – loss of charge method. Measurement of inductance- Maxwell's bridge, Hay's bridge, Anderson's bridge. Measurement of capacitance and loss angle –De Sauty's Bridge - Wien's bridge – Schering Bridge. (Qualitative approach)

UNIT - V: Sensors- Classification of transducers- Temperature sensors- Proximity sensor- Pressure sensor- IR sensors- Motion detection sensors- Ultrasonic sensors- Rotor Position Sensors, Operation of Strain Gauge- Thermocouples, construction and working of LVDT, Piezo electric transducers, photovoltaic, photo conductive cells, and photo diodes-Applications. Smart instruments: Intelligent transducer, self-diagnosis and remote calibration features, HART communication, MEMS, non-linearity compensation; smart energy meter components, working principle; Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI) environments.

TEXT BOOKS:

1. K. Sawhney, "Electrical & Electronic Measurement & Instruments", Dhanpat Rai & Co. Publications, 2005.
2. Dr. Rajendra Prasad, "Electrical Measurements & Measuring Instruments", Khanna Publishers 1989.

REFERENCE BOOKS:

1. G. K. Banerjee, "Electrical and Electronic Measurements", PHI Learning Pvt. Ltd., 2nd Edition, 2016.
2. R. K. Rajput, "Electrical & Electronic Measurement & Instrumentation", S. Chand and Company Ltd., 2007.
3. S. C. Bhargava, "Electrical Measuring Instruments and Measurements", BS Publications, 2012.
4. Buckingham and Price, "Electrical Measurements", Prentice – Hall, 1988.
5. Reissland, M. U, "Electrical Measurements: Fundamentals, Concepts, Applications", New Age International (P) Limited Publishers, 1st Edition 2010.
6. E.W. Golding and F. C. Widdis, "Electrical Measurements and measuring Instruments", fifth Edition, Wheeler Publishing, 2011.

ELECTRONIC RESOURCES:

1. https://www.electrical4u.com/electrical-measuring-instruments/
2. https://www.electrical4u.com/measurement-of-power/
3. https://www.electrical4u.com/measurement-of-power/
4. https://www.electrical4u.com/ac-bridges/
5. https://www.electronics-tutorials.ws/io/io_1.html
6. https://www.electricaltechnology.org/2019/06/smart-energy-meter.html
7. https://archive.nptel.ac.in/courses/108/105/108105153/

MATERIALS ON LINE:

1. Course template
2. Tutorial question bank
3. Tech talk and Concept Video topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper–I
8. Model question paper–II
9. Lecture notes
10. E-Learning Readiness Videos (ELRV)