National Curriculum and Credit Framework (NCCF)

Syllabus

for

ELECTRONICS

w.e.f. Academic Session 2023-24

Kazi Nazrul University

Asansol, Paschim Bardhaman

West Bengal 713340

SEMESTER- VII

MAJOR COURSE - 14

Course Name : **INTRUMENTATION AND MEASUREMENTS**

Course Code : **BSCELCMJ701**

<table>
<tr><td colspan="2">Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-14</td><td colspan="2">L-T-P: 3 – 0 – 4</td></tr>
<tr><td rowspan="3">Credit: 5</td><td rowspan="3">Full Marks: 100</td><td colspan="2">CA Marks</td><td colspan="2">ESE Marks</td></tr>
<tr><td>Practical</td><td>Theoretical</td><td>Practical</td><td>Theoretical</td></tr>
<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
</table>

Course Learning Outcomes:

- **Quantify** measurement errors and **analyze** instrument characteristics to ensure accurate data acquisition.
- **Measure** electrical parameters (R, L, C, frequency) using bridge networks and **demonstrate** the working of ADC/DAC and digital instruments.
- **Operate** oscilloscopes and signal generators, and **select** appropriate probes and connectors for safe and effective testing of electronic circuits.

INTRUMENTATION AND MEASUREMENTS (Theory)

Unit-I **[14]**

Qualities of Measurement: Specifications of Instruments and their Static and Dynamic Characteristics, Error (Gross Error, Systematic Error, Absolute Error and Relative Error) and Uncertainty Analysis, Statistical Analysis of Data and Curve Fitting.

Basic Measurement Instruments: PMMC Instrument, Galvanometer, DC Measurement, Ammeter, Voltmeter, Ohm Meter, AC Measurement, Digital Voltmeter (Integrating and Nonintegrating Types) System, Digital Multimeter, Digital Frequency Meter System.

Unit-II **[20]**

Measurement of Resistance and Impedance: Low Resistance by Kelvin's Double Bridge Method, Medium Resistance by Voltmeter Ammeter Method and Wheatstone Bridge Method, High Resistance by Megger AC Bridges, Measurement of Self Inductance, Maxwell's Bridge, Hay's Bridge and Anderson's Bridge, Measurement of Capacitance, Schering's Bridge, De-Sauty's Bridge, Measurement of Frequency, Wien's Bridge.

A-D and D-A Conversion: Circuit and Working of 4 Bit Binary Weighted Resistor Type and R-2R Ladder Type D-A Conversion, Circuit of A-D Conversion, Characteristics, Successive Approximation ADC, (Mention of Relevant ICs for all).

Unit-III **[12]**

Oscilloscope: CRT, Waveform Display and Electrostatic Focusing, Time Base and Sweep Synchronization, Measurement of Voltage, Frequency and Phase by CRO, Oscilloscope Probes, Block Diagram, Working Principle, Advantages and Applications of Dual Trace Oscilloscope, Sampling Oscilloscope, Digital Storage Oscilloscope, CRO Specifications (Bandwidth, Sensitivity, Rise Time).

Unit-IV **[10]**

Signal Generators: Audio Oscillator, Pulse Generator, Function Generators.

Connectors and Probes: Low Capacitance Probes, High Voltage Probes, Current Probes, Identifying Electronic Connectors, Audio and Video, RF/Coaxial, USB etc.

Reference Books:

- Kalsi, Electronic Instrumentation, Tata McGraw Hill.
- Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson.
- Patranabis, Principles of Electronic Instrumentation, PHI.
- Carr, Elements of Electronic Instrumentation and Measurement, Pearson.
- Bell, Electronic Instrumentation and Measurements, Oxford.
- Oliver and Cage, Electronic Measurements and Instrumentation, Tata Mcgraw Hill.
- Morris, Measurement and Instrumentation Principles, Elsevier (Buterworth-Heinmann).
- Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai.
- Rangan, Sarma and Mani, Instrumentation Devices and Systems, Tata McGraw Hill.
- Ghosh, Introduction to Measurements and Instrumentation, PHI.

INTRUMENTATION AND MEASUREMENTS (Practical)

Course Learning Outcomes:

(After the completion of course, the students will have ability to):

1. **Design** multi-range ammeters, voltmeters, and instrumentation amplifiers using galvanometers and 741 Op-Amps for measurement and signal conditioning applications.

2. **Apply** Wheatstone Bridge, Kelvin's Double Bridge, and De-Sauty's Bridge techniques for precise measurement of resistance and capacitance.

3. **Analyze** bridge sensitivity and balance conditions to evaluate the accuracy and reliability of various bridge measurement methods.

List of Experiments:

1. Design of Multi Range Ammeter and Voltmeter using Galvanometer.
2. Measurement of Resistance by Wheatstone Bridge and Measurement of Bridge Sensitivity.
3. Measurement of Capacitance by De-Sauty's.
4. Measure of Low Resistance by Kelvin's Double Bridge.
5. Design and Implementation of Instrumentation Amplifier using 741 Op-Amp.

MAJOR COURSE - 15

Course Name : **SATELLITE COMMUNICATION**

Course Code : **BSCELCMJ702**

<table>
<tr><td colspan="1">Course Type: Major (Theoretical & Tutorial)</td><td colspan="3">Course Details: MJC-15</td><td colspan="2">L-T-P: 4 – 1 – 0</td></tr>
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<tr><td></td><td>30</td><td></td><td>70</td></tr>
</table>

Course Learning Outcomes:

After the completion of course, the students will have ability to:

- To introduce the fundamentals of satellite communication and orbital mechanics.
- To explain the working of satellite subsystems and earth stations.
- To understand satellite link design, modulation, and multiple access techniques.
- To provide knowledge of satellite navigation and its applications.

SATELLITE COMMUNICATION

[Credits: 4; Lecture Hours: 60]

Unit-I [15 Hours]

Fundamentals of Satellite Communication and Orbital Dynamics: Overview of Satellite Communication, Historical Development and Applications, Indian Activities in Satellite Communication, Types of Satellites (GEO, MEO, LEO and HEO), Satellite Frequency Allocation and Frequency Bands, Orbital Mechanics, Kepler's Three Laws of Planetary Motion, Orbit of a Satellite, Look Angle Determination, Satellite Launches and Launch Vehicles (Introduction), Orbital Perturbations.

Unit-II [15 Hours]

Satellite Subsystems and Earth Stations: Space Segment and Ground Segment, Satellite Subsystems: Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command (TT&C), Power Subsystem, Communication Payload and Transponders, Satellite Antennas. Earth Stations: Earth Station Architecture, Earth Station Antennas, Transmitters and Receivers, High Power Amplifier (HPA), Low Noise Amplifier (LNA).

Unit-III [15 Hours]

Satellite Link Design and Multiple Access Techniques: Satellite Link Design and Multiple Access Techniques: Basic Transmission Theory, Free-space Path Loss, Link Budget Analysis: Uplink, Downlink and Carrier-to-Noise Ratio (C/N), System Noise Temperature, Figure of Merit (G/T Ratio), Rain Attenuation, Interference in Satellite Links, Analog and Digital Modulation Techniques, Multiple Access Techniques: FDMA, TDMA and CDMA.

Unit-IV [15 Hours]

Satellite Navigation and Applications: Satellite Navigation and Applications: Principles of Satellite Navigation, Global Positioning System (GPS), GPS Positioning Principle, GPS Receivers, Mobile Satellite Communication, Indian Satellite Systems: INSAT, GSAT and NAVIC (Introduction), Applications of Satellite Communication.

SATELLITE COMMUNICATION (Tutorial)

[Credits: 1; Lecture Hours: 15]

Course Learning Outcomes:

After the completion of course, the students will have ability to:

- Explain the basic principles of satellite communication and satellite orbits.
- Describe the functions of satellite subsystems and earth station components.
- Analyze basic satellite links and multiple access techniques.
- Explain the principles of GPS and discuss major applications of satellite communication.

SATELLITE COMMUNICATION Tutorial

- Numerical problems on orbital parameters, Kepler's laws, and look angle determination.
- Diagrammatic exercises on earth station layout.
- GPS positioning problem sets (signal travel time, accuracy).
- Case study: NAVIC applications in India.

Reference Books

• Timothy Pratt, Charles W. Bostian, Jeremy E. Allnutt — Satellite Communications (Wiley, 2003).

• Louis J. Ippolito Jr. — Satellite Communications Systems Engineering (Wiley, 2008).

• G.D. Gordon and W.L. Morgan — Principles of Communication Satellites, John Wiley & Sons, Inc.

• Barry G. Evans — Satellite Communication Systems (IET, 2008).

• A.K. Maini & V. Agarwal — Satellite Communications, John Willey.

• K.N. Rajarao — Fundamentals of Satellite Communication, Prentice Hall of India.

• Tri, T. Ha — Digital Satellite Communications, Tata McGraw Hill.

MAJOR COURSE - 16

Course Name : **MICROWAVE SYSTEM**

Course Code : **BSCELCMJ703**

<table>
<tr><td colspan="2">Course Type: Major (Theoretical & Practical)</td><td colspan="3">Course Details: MJC-16</td><td colspan="2">L-T-P: 4 - 1 - 0</td></tr>
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<tr><td></td><td>30</td><td></td><td colspan="2">70</td></tr>
</table>

Course Learning Outcomes:

- Understand various microwave system components their properties.
- Appreciate that during analysis/ synthesis of microwave systems, the different mathematical treatment is required compared to general circuit analysis.
- Design microwave systems for different practical application.

MICROWAVE SYSTEM (Theory)

Unit-I **[15]**

Introduction to Microwaves-History of Microwaves, Microwave bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC**.**

Frequency Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission.

Analysis of RF and Microwave Transmission Lines- Coaxial line, Rectangular waveguide, Circular waveguide, Strip line, Micro strip line.

Unit-II **[15]**

Microwave Network Analysis- Equivalent voltages and currents for non-TEM lines, Network parameters for microwave circuits, Scattering Parameters.

Passive and Active Microwave Devices- Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers. Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes: Klystron, TWT, Magnetron.

Unit-III **[20]**

Microwave Design Principles-Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design.

Microwave Measurements (Qualitative study)- Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure.

Unit-IV **[10]**

Microwave Systems- Radar, Terrestrial and Satellite Communication, Radio Aidsto Navigation, RFID, GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging.

Reference Books:

- R.E. Collins, Microwave Circuits, McGraw Hill
- K.C. Gupta and I.J. Bahl, Microwave Circuits, Artech house.

MAJOR COURSE - 17

Course Name **: SENSORS AND TRANSDUCERS**

Course Code **: BSCELCMJ704**

Course Type: **Major (Theoretical & Tutorial)**	Course Details: **MJC-17**			L-T-P: **4 – 1 – 0**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			30		**70**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

- To understand the fundamental concept of sensor and transducer.
- Describe the operation of various electrical and non-electrical sensors.
- Apply appropriate sensors and basic signal conditioning techniques for measurement applications.
- Explain the concepts and applications of MEMS, thin-film, and smart sensors.

SENSORS AND TRANSDUCERS

[Credits: 4; Lecture Hours: 60]

Unit-I [15 Hours]

Fundamentals of Sensors and Transducers

Definitions: sensors, transducers, actuators; Principles of operation and classification; Primary vs secondary, active vs passive, analog vs digital sensors; Static characteristics: accuracy, precision, sensitivity, resolution, linearity, hysteresis, error analysis; Dynamic characteristics: zero-order, first-order, second-order systems, step response, dynamic errors; Calibration: standards, Basic measurement uncertainty and calibration procedures, loading effects.

Unit-II [15 Hours]

Electrical and Non electrical Sensing Elements

Resistive Sensors: Potentiometers, Strain Gauges (metal and semiconductor), Gauge Factor, Load Cell, Resistance Temperature Detector (RTD), Thermistor. Capacitive Sensors: Principle of Operation, Variable Gap, Variable Area, Variable Dielectric Constant, Applications. Inductive Sensors: Variable Reluctance Sensors, Linear Variable Differential Transformer (LVDT), Rotary Variable Differential Transformer (RVDT), Eddy Current Sensors. Magnetic and Piezoelectric Sensors: Hall Effect Sensor, Piezoelectric Sensors, Magnetoresistive Sensors (Basic Principle and Applications). Applications: Measurement of Displacement, Position, Force, Pressure, Temperature, and Level.

Unit-III [15 Hours]

Optical, Radiation, and Chemical Sensors

Photo Detectors: Photodiodes, Photoresistors, Phototransistors, LDR (Light Dependent Resistor) sensors ; Fiber Optic Sensors: Principles and Applications; Nuclear Radiation

Sensors (overview only); Chemical Sensors: pH Sensors, Gas Sensors and Biosensors (working principle and applications). Emphasis on Practical Applications in Industry, Environment, and Biomedical Fields.

Unit-IV [15 Hours]

Modern Sensor Technologies and Applications

Thin-Film Sensors: Structure, Materials (ZnO, SnO_2, Polymers – Overview Only), Applications in Temperature, Gas, Pressure Sensing. Introduction to MEMS: Definition, Scope, Microsensors, Microactuators, Functional Domains. Smart Sensors: Sensor Interfacing, Excitation, Amplification, Filtering, Basic Signal Conditioning, Data Communication, and IoT-Enabled Sensors. Applications: Automotive Sensors, Home Appliances, Aerospace, Manufacturing, IoT, Healthcare, Robotics, and Environmental Monitoring.

SENSORS AND TRANSDUCERS (Tutorial)

[Credits: 1; Lecture Hours: 15]

Course Learning Outcomes:

After the completion of course, the students will have ability to:

- Solve numerical problems related to the characteristics, calibration, and performance of sensors and transducers.
- Analyze the operation and applications of different electrical and non-electrical sensors.
- Select appropriate sensors for engineering measurement and instrumentation applications.
- Explain the working principles and applications of MEMS, thin-film, and smart sensors through case studies and problem-solving.
- Apply sensor concepts to real-world applications in automation, healthcare, environmental monitoring, and IoT systems.

SENSORS AND TRANSDUCERS Tutorial

- Problems on classification, characteristics, calibration, and error analysis of sensors and transducers.

- Numerical problems and applications of resistive, capacitive, inductive, magnetic, and piezoelectric sensors.
- Problems and case studies on optical, thermal, radiation, gas, humidity, ultrasonic, and proximity sensors.
- Exercises on thin-film sensors, MEMS devices, and their engineering applications.
- Case studies on smart sensors, signal conditioning, sensor interfacing, IoT-based sensing, and industrial applications.

Reference Books

• D. Patranabis, *Sensors and Transducers*, 3rd Edition, PHI Learning Private Limited, 2003.

• D. V. S. Murthy, *Transducers and Instrumentation*, PHI, 2nd Ed., 2010.

• A. K. Ghosh, *Introduction to Measurements and Instrumentation*, PHI, 4th Ed., 2012.

• R. Pallas & J. G. Webster, *Sensors and Signal Conditioning*, John Wiley & Sons, 2nd Ed., 2001.

• J. P. Bentley, *Principles of Measurement Systems*, Pearson Education, New Delhi, 3rd Ed., 2007.

• A. K. Ghosh, *Introduction to Measurement and Instrumentation*, PHI, 3rd Ed., 2009.

• J. Veteline, A. Raghu, *Introduction to Sensors*, CRC press, 2011.

• C. D. Johnson, *Process control Instrumentation Technology*, PHI, 7th Ed.

• R. K. Jain, *Mechanical measurements*, Khanna Publishers, 2002.

• S. M. Sze, *Semiconductor sensors*, John Wiley & Sons Inc., 3rd Edition, 2006.

• T.-R. Hsu, *MEMS and Microsystems: Design and Manufacture*, Publisher: McGraw-Hill. 1st Ed., 2017.

• J. Fraden, *Handbook of Modern Sensors: Physics, Designs, and Applications*, Springer, 4th Ed., 2017.

• J. W. Gardner, V. K.Varadan, & O. O. Awadelkarim– *Microsensors, MEMS, and Smart Devices*, Wiley, 1st Ed., 2001.

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MINOR COURSE - 6

Course Name : **INTRUMENTATION AND MEASUREMENTS**

Course Code : **BSCELCMN601**

<table>
<tr><td>Course Type: Minor (Theoretical & Practical)</td><td colspan="3">Course Details: MNC-6</td><td colspan="2">L-T-P: 3- 0- 4</td></tr>
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<tr><td>Practical</td><td>Theoretical</td><td>Practical</td><td>Theoretical</td></tr>
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Course Learning Outcomes:

- **Quantify** measurement errors and **analyze** instrument characteristics to ensure accurate data acquisition.
- **Measure** electrical parameters (R, L, C, frequency) using bridge networks and **demonstrate** the working of ADC/DAC and digital instruments.
- **Operate** oscilloscopes and signal generators, and **select** appropriate probes and connectors for safe and effective testing of electronic circuits.

INTRUMENTATION AND MEASUREMENTS (Theory)

Unit-I **[14]**

Qualities of Measurement: Specifications of Instruments and their Static and Dynamic Characteristics, Error (Gross Error, Systematic Error, Absolute Error and Relative Error) and Uncertainty Analysis, Statistical Analysis of Data and Curve Fitting.

Basic Measurement Instruments: PMMC Instrument, Galvanometer, DC Measurement, Ammeter, Voltmeter, Ohm Meter, AC Measurement, Digital Voltmeter (Integrating and Nonintegrating Types) System, Digital Multimeter, Digital Frequency Meter System.

Unit-II **[20]**

Measurement of Resistance and Impedance: Low Resistance by Kelvin's Double Bridge Method, Medium Resistance by Voltmeter Ammeter Method and Wheatstone Bridge Method, High Resistance by Megger AC Bridges, Measurement of Self Inductance, Maxwell's Bridge, Hay's Bridge and Anderson's Bridge, Measurement of Capacitance, Schering's Bridge, De-Sauty's Bridge, Measurement of Frequency, Wien's Bridge.

A-D and D-A Conversion (Qualitative study): Circuit and Working of 4 Bit Binary Weighted Resistor Type and R-2R Ladder Type D-A Conversion, Circuit of A-D Conversion, Characteristics, Successive Approximation ADC, (Mention of Relevant ICs for all).

Unit-III **[12]**

Oscilloscope: CRT, Waveform Display and Electrostatic Focusing, Time Base and Sweep Synchronization, Measurement of Voltage, Frequency and Phase by CRO, Oscilloscope Probes, Block Diagram, Working Principle, Advantages and Applications of Dual Trace Oscilloscope, Sampling Oscilloscope, Digital Storage Oscilloscope, CRO Specifications (Bandwidth, Sensitivity, Rise Time).

Unit-IV **[10]**

Signal Generators (Qualitative study): Audio Oscillator, Pulse Generator, Function Generators.

Connectors and Probes: Low Capacitance Probes, High Voltage Probes, Current Probes, Identifying Electronic Connectors, Audio and Video, RF/Coaxial, USB etc.

Reference Books:

- Kalsi, Electronic Instrumentation, Tata McGraw Hill.
- Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson.
- Patranabis, Principles of Electronic Instrumentation, PHI.
- Carr, Elements of Electronic Instrumentation and Measurement, Pearson.
- Bell, Electronic Instrumentation and Measurements, Oxford.
- Oliver and Cage, Electronic Measurements and Instrumentation, Tata Mcgraw Hill.
- Morris, Measurement and Instrumentation Principles, Elsevier (Buterworth-Heinmann).
- Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai.
- Rangan, Sarma and Mani, Instrumentation Devices and Systems, Tata McGraw Hill.
- Ghosh, Introduction to Measurements and Instrumentation, PHI.

INTRUMENTATION AND MEASUREMENTS (Practical)

Course Learning Outcomes:

(After the completion of course, the students will have ability to):

1. **Design** multi-range ammeters, voltmeters, and instrumentation amplifiers using galvanometers and 741 Op-Amps for measurement and signal conditioning applications.
2. **Apply** Wheatstone Bridge, Kelvin's Double Bridge, and De-Sauty's Bridge techniques for precise measurement of resistance and capacitance.
3. **Analyze** bridge sensitivity and balance conditions to evaluate the accuracy and reliability of various bridge measurement methods.

List of Experiments:

1. Design of Multi Range Ammeter and Voltmeter using Galvanometer.
2. Measurement of Resistance by Wheatstone Bridge and Measurement of Bridge Sensitivity.
3. Measurement of Capacitance by De-Sauty’s.
4. Measure of Low Resistance by Kelvin’s Double Bridge.
5. Design and Implementation of Instrumentation Amplifier using 741 Op-Amp.