

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
School of Electrical, Electronics Sciences & Engineering  
**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                           |          |                              |          |              |                                |               |
|------------------------------------------------|-------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Sensors and Measurement Techniques</b> |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIT305</b>                           |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>PCC (Professional Core Course)</b>     |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                  | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>3</b>                                  | <b>0</b> | <b>0</b>                     | <b>3</b> | <b>3</b>     | <b>45+0+0+45=90</b>            | <b>3</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                      |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

| <b>Course Learning Objectives:</b> |                                                                                                                                                                                       |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CLO1                               | Understand the fundamentals of measurement systems, measuring instruments, transducers, and the functional elements of generalized measurement systems.                               |
| CLO2                               | Explain the operating principles and applications of digital measuring instruments, oscilloscopes, digital multimeters, digital frequency meters, and signal generators.              |
| CLO3                               | Apply bridge circuits and digital measurement techniques for accurate measurement of electrical quantities such as resistance, inductance, capacitance, voltage, and frequency        |
| CLO4                               | Understand the construction, operating principles, characteristics, and industrial applications of displacement and strain transducers.                                               |
| CLO5                               | Understand the principles, characteristics, calibration, and applications of various temperature measurement sensors and transducers used in industrial and engineering applications. |

| <b>SYLLABUS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>No. of Hours</b> | <b>BTLs</b>  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------|
| <b>UNIT 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>9</b>            | <b>L1-L2</b> |
| <b>Measurement, Functional Elements of Measurement System and Sensors/Transducers:</b><br>Measurement, significance of measurement, instruments and measurement systems, mechanical, electrical and electronic instruments, Analog and digital modes of operation, functions of instruments and measurement systems, applications of measurement systems, Elements of generalized measurement system, Input-output configuration of measuring instruments and measurement systems, methods of correction for interfering and modifying inputs. Transducers, Classifications of transducers-primary & secondary, active & passive, analog and digital transducers. |                     |              |
| <b>Case study:</b><br>Selection of an Appropriate Measurement System for an Industrial Process, Comparison of primary and secondary transducers in industrial automation. designing a Smart Water Tank Monitoring System, choosing a Suitable Transducer for Greenhouse Automation, Measurement systems used in aircraft instrumentation                                                                                                                                                                                                                                                                                                                          |                     |              |
| <b>UNIT 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>9</b>            | <b>L1-L2</b> |
| Digital Voltmeters, Digital Multimeters and Frequency Meters: Introduction, Ramp technique & ramp type DVM, Dual slope integrating type DVM, Successive approximation DVM, Resolution and sensitivity of digital meters. Digital multimeters, Digital frequency meter. Oscilloscope: Introduction, Basic principle, CRT features, Block diagram of oscilloscope, Dual beam oscilloscope, Dual trace oscilloscope.                                                                                                                                                                                                                                                 |                     |              |
| <b>Case study:</b><br>Troubleshooting a Power Supply Using a Digital Multimeter, Oscilloscope-Based Fault Diagnosis in a Communication Circuit, Calibration of Digital Multimeters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |              |
| <b>UNIT 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>9</b>            | <b>L1-L2</b> |

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Signal Generators: Introduction, Fixed and variable AF oscillator, Standard signal generator, Modern laboratory signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator. Bridge Circuits for Measurement of R, L & C: DC bridges: Introduction, Wheatstone bridge, Kelvin Bridge, Practical Kelvin's double bridge. AC bridges: Capacitance Comparison Bridge, Inductance Comparison Bridge, Maxwell's bridge, Schering Bridge, Wien's bridge. (Relevant problems).

**Case study:**

Frequency Measurement Using Wien Bridge, Develop an automated bridge measurement system using Arduino or Raspberry Pi, Study the role of signal generators in testing IoT and embedded systems, Compare bridge circuits with modern digital LCR meters in terms of accuracy, speed, and cost..

| UNIT 4 | 9 | L1-L2 |
|--------|---|-------|
|--------|---|-------|

. Measurement of Displacement: Introduction, Principles of Transduction: Variable resistance devices, Variable Inductance Transducer, Synchros and Resolvers, Variable Capacitance Transducer, Hall Effect Devices, Proximity Devices, Digital Transducer Measurement of Strain: Introduction, Electrical Strain Gauges, Theory of operation of resistance strain gauges, Types of Electrical Strain Gauges – Wire gauges, unbounded strain gauges, foil gauges, Semiconductor strain gauges (principle, types & list of characteristics only), Materials for strain gauges. Wheatstone bridge circuit for strain gauges, Applications.

**Case study:**

Automatic Door Position Monitoring, Smart Elevator Position Control, Structural Health Monitoring of a Bridge (using wheatstone bridge), Design of a strain measurement system for an electric vehicle chassis, Industrial applications of displacement and strain transducers in Industry 4.0.

| UNIT 5 | 9 | L1-L2 |
|--------|---|-------|
|--------|---|-------|

Measurement of Temperature: Introduction, Mechanical temperature sensors, Resistance type temperature sensors, platinum resistance thermometer, thermistors (principle, types & characteristics), thermocouples solid state sensors – principle and working, brief discussion on AD590 (characteristics and features), LM35 (characteristics and features), Quartz thermometer, Temperature measurement by radiation methods, Optical pyrometer, Calibration of thermometers

**Case study:**

Selection of **LM35 or AD590** for an IoT-based weather monitoring station, Temperature monitoring in food processing industries, Temperature monitoring in electric vehicle battery management systems, Comparison of **RTD, Thermistor, and Thermocouple** for industrial temperature measurement.

| TEXT BOOKS: |                                                                                                                                                                  |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.(Module-1).           |
| 2           | Electronic Instrumentation - H. S. Kalsi, TMH, 3rd Edition, 2012 (Module-2 & 3)                                                                                  |
| 3           | Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014. (Module 4 & 5). |

| REFERENCE BOOKS: |                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------|
| 1                | Electronic Instrumentation and Measurements - David A Bell, 3rd Edition, Oxford University Press, 2013. |

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|                              |                                                                                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 2                            | Transducers and Instrumentation – D.V.S.Murty, 2nd Edition, PHI, 2009                                                           |
| 3                            | Introduction to Measurements and Instrumentation - A. K. Ghosh, 2nd Edition, PHI, 2007.                                         |
| 4                            | Instrumentation Measurement and Analysis- B.C.Nakra and K.K.Choudhry, 3rd Edition, McGraw Hill Education (India) Pvt.Ltd. 2009. |
| 5                            | Measurement Systems Application and Design- Ernest O.Doeblin and Dhanesh N Manik, 5th Edition, McGraw Hill, 2007.               |
| <b>e-LEARNING RESOURCES:</b> |                                                                                                                                 |
| 1                            | <a href="https://nptel.ac.in/courses/108105153">https://nptel.ac.in/courses/108105153</a>                                       |
| 2                            | <a href="https://nptel.ac.in/courses/108105064">https://nptel.ac.in/courses/108105064</a>                                       |
| 3                            | <a href="https://www.youtube.com/watch?v=hxfOdn8Bjh8">https://www.youtube.com/watch?v=hxfOdn8Bjh8</a>                           |
| 4                            | <a href="https://www.youtube.com/watch?v=As5kzxkyT24">https://www.youtube.com/watch?v=As5kzxkyT24</a>                           |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.  
**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.  
**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.  
**\*\*Self-Study Component should be not included for SEE & CIE.**

| CONTINUOUS INTERNAL EVALUATION (CIE) |                                          | Max. Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|--------------------------------------|------------------------------------------|------------|------------------------------------------------------------------------------|
| Theory                               | Weightage of CIE1 and CIE2 Tests or CIE3 | 50         | 20                                                                           |
| TOTAL                                |                                          | 50         | 20                                                                           |

**QUESTION PAPER PATTERN (SEE)**

| Q. No.                                                                                  | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
|-----------------------------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|-----|
| UNIT                                                                                    | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10  |
| 1. Two full questions (each of 20 Marks) are to be set from each unit.                  |    |    |    |    |    |    |    |    |    |     |
| 2. Student shall answer five full questions selecting one full question from each unit. |    |    |    |    |    |    |    |    |    |     |

**Course Outcomes:** After the completion of the course, the student will be able to:

|            |                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Define the measurement, instrument, transducer, and explain the functional elements of generalized instrumentation / measurement system. |
| <b>CO2</b> | Explain the principle and working of digital instruments, oscilloscopes and function generators.                                         |
| <b>CO3</b> | Analyze and use appropriate circuits for the measurement of resistance, capacitance, inductance and frequency.                           |

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|            |                                                                                                                |
|------------|----------------------------------------------------------------------------------------------------------------|
| <b>CO4</b> | Discuss the principle, construction and working of transducers for the measurement of displacement and strain. |
| <b>CO5</b> | Discuss the principle, construction and working of transducers for the measurement of temperature              |

| <b>Mapping of CO's, PO's with PSO's</b>                                                                   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO                                                                                                        | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                       | 1   | 1   |     |     | 2   | 1   |     |     |     |      | 1    | 3    | 1    |      |
| CO2                                                                                                       | 1   | 1   |     |     | 2   | 1   |     |     |     |      | 1    | 3    | 1    |      |
| CO3                                                                                                       | 1   | 1   | 2   |     | 2   | 1   |     |     |     |      | 1    | 3    | 1    |      |
| CO4                                                                                                       | 1   | 1   |     |     | 3   | 1   |     |     |     |      | 1    | 3    | 1    |      |
| CO5                                                                                                       | 1   | 1   |     |     | 3   | 1   |     |     |     |      | 1    | 3    | 1    |      |

| <b>Mapping of CO's with Knowledge and Attitude Profile (WK)</b>                                           |     |     |     |     |     |     |     |     |     |  |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |  |
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                                                                                                       | 3   | 2   |     |     |     |     |     |     |     |  |
| CO2                                                                                                       | 3   | 2   |     | 2   |     |     |     |     |     |  |
| CO3                                                                                                       | 3   | 3   | 2   |     | 2   |     |     |     |     |  |
| CO4                                                                                                       | 3   | 2   |     | 2   |     |     |     |     |     |  |
| CO5                                                                                                       | 3   | 2   |     | 2   |     |     |     |     |     |  |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CO1                                                                                                       |   |   |   | 3 |   |   |   |   | 2 |    |    |    |    |    |    |    |    |
| CO2                                                                                                       |   |   |   | 3 |   |   | 2 |   | 3 |    |    |    |    |    |    |    |    |
| CO3                                                                                                       |   |   |   | 2 |   |   | 2 |   | 3 |    |    | 2  |    |    |    |    |    |
| CO4                                                                                                       |   |   | 2 | 2 |   |   |   |   | 3 |    |    |    |    |    |    |    |    |
| CO5                                                                                                       |   |   | 3 | 2 |   |   | 2 |   | 3 |    |    | 2  | 2  |    |    |    |    |

**Course Coordinators:**

Dr. Shubha P  
Associate Professor,  
EIE

**Heads of Programme:**

**Head of School**

|                                                                                        |                                                                                                                 |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Dr. Ganapathi. V Sagar<br>Professor,<br>Electronics and Instrumentation<br>Engineering | Dr. H V Govindaraju ,<br>Professor,<br>School of Electrical, Electronics Sciences &<br>Engineering<br>Dr. A.I.T |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|

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|------------------------------------------------|----------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Measurement and Transducers Lab</b>             |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL307A</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                           | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                           | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                               |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

|                                    |                                                           |
|------------------------------------|-----------------------------------------------------------|
| <b>Course Learning Objectives:</b> |                                                           |
| CLO1                               | Understand the characteristics of different sensors       |
| CLO2                               | Familiarize with signal conditioning circuits             |
| CLO3                               | Understand the calibration of different sensors           |
| CLO4                               | understand the Operation of Digital and analog conversion |

| <b>Syllabus</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                  |
| 1                                                                                                                                                                                                                                                                                                                                                  | Measurement of unknown resistance by Wheatstone bridge and finding the sensitivity of the bridge.                                                                                |
| 2                                                                                                                                                                                                                                                                                                                                                  | Measurement of low resistance using Kelvin double bridge.                                                                                                                        |
| 3                                                                                                                                                                                                                                                                                                                                                  | Measurement of self-inductance using Maxwell's bridge.                                                                                                                           |
| 4                                                                                                                                                                                                                                                                                                                                                  | Measurement of unknown capacitance using Schering's bridge.                                                                                                                      |
| 5                                                                                                                                                                                                                                                                                                                                                  | Measurement of displacement using LVDT and finding the sensitivity & resolution                                                                                                  |
| 6                                                                                                                                                                                                                                                                                                                                                  | Characteristics of Load cell and Cantilever beam using Strain gauge: Plotting the characteristics and finding their sensitivity for Quarter, Half and Full bridge configurations |
| 7                                                                                                                                                                                                                                                                                                                                                  | Temperature measurement using RTD, Thermistor and Thermocouple: Plotting the characteristics and finding their sensitivity                                                       |
| 8                                                                                                                                                                                                                                                                                                                                                  | Temperature measurement using AD590 / LM35: Plotting the characteristics and finding their sensitivity.                                                                          |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                  |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                                                                                                                  |
| 1                                                                                                                                                                                                                                                                                                                                                  | Characteristics of LDR, Photodiode & Phototransistor by variable illumination & variable distance, and plotting their characteristics.                                           |
| 2                                                                                                                                                                                                                                                                                                                                                  | Calibration of voltmeter and ammeter using DC potentiometer.                                                                                                                     |
| 3                                                                                                                                                                                                                                                                                                                                                  | Characteristics of potentiometric transducer/capacitance transducer                                                                                                              |
| 4                                                                                                                                                                                                                                                                                                                                                  | Measurement of unknown capacitance/frequency using Wein's bridge.                                                                                                                |

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| Teaching & Learning Process (Innovative Delivery Methods): |                                      |
|------------------------------------------------------------|--------------------------------------|
| 1                                                          | Active Learning Techniques           |
| 2                                                          | Problem-Based Learning (PBL)         |
| 3                                                          | Team-Based Learning (TBL)            |
| 4                                                          | Hands-On Experiments and Simulations |

| TEXT BOOKS: |                                                                                                                                            |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004 |
| 2           | Electronic Instrumentation - H. S. Kalsi, TMH, 3rd Edition, 2012                                                                           |

| REFERENCE BOOKS:      |                                                                                                                                  |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 1                     | Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32 <sup>nd</sup> )                  |
| e-LEARNING RESOURCES: |                                                                                                                                  |
| 1                     | Wheatstone Bridge Circuit: <a href="https://www.youtube.com/watch?v=xyZ6CD6G3Ro">https://www.youtube.com/watch?v=xyZ6CD6G3Ro</a> |
| 2                     | LVDT: <a href="https://www.youtube.com/watch?v=Fxr34WGNMdw">https://www.youtube.com/watch?v=Fxr34WGNMdw</a>                      |
| 3                     | Strain Gauge / Load Cell: <a href="https://www.youtube.com/watch?v=y877qjkmsDQ">https://www.youtube.com/watch?v=y877qjkmsDQ</a>  |
| 4                     | Kelvin Double Bridge: <a href="https://www.youtube.com/watch?v=rDPcBqtn6yE">https://www.youtube.com/watch?v=rDPcBqtn6yE</a>      |

| Assessment Details both (CIE and SEE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                           |            |                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------|------------------------------------------------------------------------------|
| <p>The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.</p> <p><b>**Self-Study Component should be not included for SEE &amp; CIE.</b></p> |                                                           |            |                                                                              |
| CONTINUOUS INTERNAL EVALUATION (CIE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                           | Max. Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
| Laboratory components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Rubrics for each experiment are added, then taken average | 30         | 20                                                                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Lab CIE                                                   | 20         |                                                                              |
| TOTAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                           | 50         | 20                                                                           |

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| <b>Course Outcomes:</b> After the completion of the course, the student will be able to: |                                                                                                                                                |
| <b>CO1</b>                                                                               | Measure unknown values of resistance, capacitance and inductance using different bridges.                                                      |
| <b>CO2</b>                                                                               | Analyze the response and plot the characteristics of displacement measuring transducers such as LVDT and Potentiometric transducer             |
| <b>CO3</b>                                                                               | Analyze the response and plot the characteristics of temperature measurement transducers such as RTD, Thermistor, Thermocouple, AD590 and LM35 |
| <b>CO4</b>                                                                               | Analyze the response and plot the characteristics of strain gauge                                                                              |

| <b>Mapping of CO's, PO's with PSO's</b>                                                                   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO                                                                                                        | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| <b>CO1</b>                                                                                                | 3   | 2   | 2   | 2   | 2   | 1   |     |     | 2   |      |      | 3    | 1    | 1    |
| <b>CO2</b>                                                                                                | 3   | 2   | 2   | 2   | 2   | 1   |     |     | 2   |      |      | 3    | 2    | 2    |
| <b>CO3</b>                                                                                                | 3   | 2   | 2   | 2   | 2   | 1   |     |     | 2   |      |      | 3    | 2    | 2    |
| <b>CO4</b>                                                                                                | 3   | 2   | 2   | 2   | 2   | 1   |     |     | 2   |      |      | 2    | 3    | 3    |

| <b>Mapping of CO's with Knowledge and Attitude Profile (WK)</b>                                           |     |     |     |     |     |     |     |     |     |  |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |  |
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| <b>CO1</b>                                                                                                | 3   | 3   | 3   | 1   | 1   | 1   |     |     |     |  |
| <b>CO2</b>                                                                                                | 3   | 3   | 3   | 1   | 1   | 1   |     |     |     |  |
| <b>CO3</b>                                                                                                | 3   | 3   | 3   | 1   | 1   | 1   |     |     |     |  |
| <b>CO4</b>                                                                                                | 3   | 3   | 3   | 1   | 1   | 1   |     |     |     |  |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| <b>CO1</b>                                                                                                |   |   |   | 3 |   |   |   | 1 | 3 |    |    | 1  |    |    |    |    |    |
| <b>CO2</b>                                                                                                |   |   |   | 3 |   |   | 1 | 1 | 3 |    |    | 1  |    |    |    |    |    |
| <b>CO3</b>                                                                                                |   |   | 2 | 3 |   |   | 1 | 1 | 3 |    |    | 1  | 1  |    |    |    |    |
| <b>CO4</b>                                                                                                |   |   |   | 3 |   |   | 1 | 1 | 3 |    |    | 1  |    |    |    |    |    |

**Course Coordinators:**

|                                                     |  |  |
|-----------------------------------------------------|--|--|
| Mrs Nikhila S<br>Assistant Professor,<br><b>EIE</b> |  |  |
|-----------------------------------------------------|--|--|

**Heads of Programme:**

**Head of School**

|                                                                                        |                                                                                                           |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Dr. Ganapathi. V Sagar<br>Professor,<br>Electronics and Instrumentation<br>Engineering | Dr. H V Govindaraju ,<br>Professor,<br>School of Electrical, Electronics Sciences & Engineering Dr. A.I.T |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
School of Electrical, Electronics Sciences & Engineering  
**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                                    |          |                              |          |              |                                |               |
|------------------------------------------------|----------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Python for measurement Lab</b>                  |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL307B</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                           | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                           | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                               |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

| <b>Course Learning Objectives:</b> |                                                                                                                                   |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| CLO1                               | To introduce Python programming concepts and computational tools in measurements and instrumentation system                       |
| CLO2                               | To acquire, analyze and visualizing characteristics of real-time sensor using graphical tools.                                    |
| CLO3                               | To expose students to modern IoT and cloud-based monitoring systems by integrating sensor data with platforms such as ThingSpeak. |

| <b>Syllabus</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                      |
| 1                                                                                                                                                                                                                                                                                                                                                  | Compute the basic measurements statics manually and compare with NumPy outputs.                                                                                                      |
| 2                                                                                                                                                                                                                                                                                                                                                  | To simulate various instrumentation errors (systematic, random, zero drift, calibration error, quantization error) using Python and visualize their effects on measurement accuracy. |
| 3                                                                                                                                                                                                                                                                                                                                                  | Compute mean, median, standard deviation, variance, and measurement uncertainty of a given sensor dataset using NumPy. Interpret the spread and accuracy of sensor readings          |
| 4                                                                                                                                                                                                                                                                                                                                                  | To perform various circuit calculations- Resistor value, voltage divider, frequency and period calculation                                                                           |
| 5                                                                                                                                                                                                                                                                                                                                                  | Acquire real-time sensor data (temperature, humidity, LDR) from an Arduino/ESP32 via pyserial. Display live readings in console. Plot the graph of time stamped data to a CSV file   |
| 6                                                                                                                                                                                                                                                                                                                                                  | Python program to simulate various types of bridges                                                                                                                                  |
| 7                                                                                                                                                                                                                                                                                                                                                  | To simulate simple P,I,D controller in Python                                                                                                                                        |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                      |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                                                                                                                      |
| 1                                                                                                                                                                                                                                                                                                                                                  | Simulate thermocouple and plot the characteristic plot of voltage vs temperature in python.                                                                                          |
| 2                                                                                                                                                                                                                                                                                                                                                  | Python program to send sensor data to cloud platform using ThingSpeak                                                                                                                |
| 3                                                                                                                                                                                                                                                                                                                                                  | Design and implement low-pass, high-pass, and band-pass FIR/IIR digital filters on a noisy measurement signal. Compare filtered vs raw signal and measure SNR improvement            |

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| <b>Teaching &amp; Learning Process</b> (Innovative Delivery Methods): |                                      |
|-----------------------------------------------------------------------|--------------------------------------|
| 1                                                                     | Active Learning Techniques           |
| 2                                                                     | Problem-Based Learning (PBL)         |
| 3                                                                     | Team-Based Learning (TBL)            |
| 4                                                                     | Hands-On Experiments and Simulations |

| <b>TEXT BOOKS:</b> |                                                                                                                                                         |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                  | Real-World Instrumentation with Python: Automated Data Acquisition and Control Systems, John M. Hughes, O'Reilly Media, Inc., 2010, ISBN: 9780596809560 |
| 2                  | Python Data Science Handbook, Jake VanderPlas, O'Reilly Media, 2016                                                                                     |

| <b>REFERENCE BOOKS:</b>      |                                                                                                         |
|------------------------------|---------------------------------------------------------------------------------------------------------|
| 1                            | Scientific Computing with Python, Claus Fuhrer, Jan Erik Solem, Olivier Verdier, Packt Publishing, 2021 |
| <b>e-LEARNING RESOURCES:</b> |                                                                                                         |
| 1                            | <a href="https://www.vlab.co.in/">https://www.vlab.co.in/</a>                                           |
| 2                            | Videos and Lecture Notes: <a href="http://www.nptel.ac.in">http://www.nptel.ac.in</a>                   |

| <b>Assessment Details both (CIE and SEE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                           |                   |                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-------------------|------------------------------------------------------------------------------|
| <p>The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.</p> <p><b>**Self-Study Component should be not included for SEE &amp; CIE.</b></p> |                                                           |                   |                                                                              |
| <b>CONTINUOUS INTERNAL EVALUATION (CIE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                           | <b>Max. Marks</b> | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
| <b>Laboratory components</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Rubrics for each experiment are added, then taken average | <b>30</b>         | <b>20</b>                                                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Lab CIE</b>                                            | <b>20</b>         |                                                                              |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                           | <b>50</b>         | <b>20</b>                                                                    |

**Course Outcomes:** After the completion of the course, the student will be able to:

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|            |                                                                                                                     |
|------------|---------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Understand the basic theories, principles of different measurement techniques.                                      |
| <b>CO2</b> | Simulate circuit parameters, sensor characteristics and measurement system in python                                |
| <b>CO3</b> | Analyze instrumentation systems, PID controller responses through simulation.                                       |
| <b>CO4</b> | Develop Python programs for data acquisition, data processing, file handling, and visualization of measurement data |
| <b>CO5</b> | Visualize the sensor data report on cloud-based platform                                                            |

| <b>Mapping of CO's, PO's with PSO's</b>                                                                   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO                                                                                                        | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                       | 3   | 2   | 1   | 1   | 1   |     |     |     |     |      |      | 3    | 1    | 1    |
| CO2                                                                                                       | 3   | 3   | 2   | 2   | 2   |     |     |     |     |      |      | 3    | 2    | 2    |
| CO3                                                                                                       | 3   | 2   | 2   | 1   | 2   | 2   |     |     |     |      | 2    | 3    | 2    | 2    |
| CO4                                                                                                       | 2   | 2   | 2   | 2   | 2   | 2   |     |     |     |      | 2    | 2    | 3    | 3    |
| CO5                                                                                                       | 2   | 2   | 1   | 1   | 2   | 1   |     |     |     |      | 1    | 1    | 3    | 3    |

| <b>Mapping of CO's with Knowledge and Attitude Profile (WK)</b>                                           |     |     |     |     |     |     |     |     |     |  |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |  |
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                                                                                                       | 1   | 1   | 2   | 2   | 1   | 3   | 1   | 0   | 0   |  |
| CO2                                                                                                       | 1   | 1   | 2   | 2   | 2   | 3   | 1   | 0   | 0   |  |
| CO3                                                                                                       | 1   | 2   | 2   | 2   | 2   | 3   | 1   | 1   | 0   |  |
| CO4                                                                                                       | 1   | 1   | 2   | 3   | 3   | 3   | 2   | 1   | 1   |  |
| CO5                                                                                                       | 1   | 1   | 2   | 3   | 3   | 2   | 2   | 2   | 2   |  |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CO1                                                                                                       |   |   |   | 2 |   |   |   |   | 1 |    |    |    |    |    |    |    |    |
| CO2                                                                                                       |   |   | 1 | 1 |   |   | 1 |   | 2 |    |    | 1  |    |    |    |    |    |
| CO3                                                                                                       |   |   |   | 1 |   |   | 1 | 1 | 2 |    |    | 1  |    |    |    |    |    |
| CO4                                                                                                       |   |   | 1 | 1 |   |   | 1 | 1 | 2 |    | 1  | 1  |    |    |    |    |    |
| CO5                                                                                                       |   | 1 | 1 | 1 |   | 1 | 1 | 1 | 3 |    | 2  | 1  | 1  |    |    |    | 1  |

**Course Coordinators:**

|                                                        |  |  |
|--------------------------------------------------------|--|--|
| Mrs. Soumya B S,<br>Assistant Professor,<br><b>EIE</b> |  |  |
|--------------------------------------------------------|--|--|

**Heads of Programme:**

Dr. Ganapathi. V Sagar  
Professor,  
Electronics and  
Instrumentation Engineering

**Head of School**

Dr. H V Govindaraju ,  
Professor,  
School of Electrical, Electronics Sciences &  
Engineering, Dr. A.I.T

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**Scheme: 2025**

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|                                                |                                                    |          |                              |          |              |                                |               |
|------------------------------------------------|----------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Virtual Instrumentation Lab</b>                 |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL307C</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                           | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                           | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                               |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

|                                    |                                                                                       |
|------------------------------------|---------------------------------------------------------------------------------------|
| <b>Course Learning Objectives:</b> |                                                                                       |
| CLO1                               | To introduce the concept of virtual instrumentation and to develop basic VI programs  |
| CLO2                               | Build a simple data acquisition application using MyDAQ.                              |
| CLO3                               | Develop interest and skill to build a real time Programming Architectures in LabVIEW. |

| <b>Syllabus</b>                           |                                                                                                                                                                                                                                                                             |                      |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b> |                                                                                                                                                                                                                                                                             |                      |
| 1                                         | Basic operations, simple programming structure using LabVIEW.<br>a. Basic arithmetic operations<br>b. Boolean operations<br>c. Sum of n numbers using for loop<br>Sorting even numbers using while loop in an array                                                         |                      |
| 2                                         | To explore the following programming tools in LabVIEW;<br>a. Creating a Sub VI<br>b. Working with Formula Nodes & Expression Nodes<br>c. Working with Loops & CASE structures<br>Usage of Charts and Graphs                                                                 |                      |
| 3                                         | To explore the following programming tools in LabVIEW;<br>a. Shift Registers<br>b. Arrays<br>c. String handling<br>File I/O                                                                                                                                                 |                      |
| 4                                         | Design a VI for programmable Function Generator for the following functionalities.<br>a. Waveform generating options for generating – Sine, Triangle, Saw tooth & Square Waveforms.<br>b. Digital Display for Magnitude & Frequency<br>Graphical chart for analog waveform. |                      |
| 5                                         | Using VISA and serial communication, Design a VI for the following programmable Instrument with couple of LED indicators.                                                                                                                                                   |                      |
|                                           | <b>ASCII Command</b>                                                                                                                                                                                                                                                        | <b>Functionality</b> |

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                       |   |                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------------|
|                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                       | A | LED Indicator 1 - ON  |
|                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                       | B | LED Indicator 1 – OFF |
|                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                       | C | LED Indicator 2 - ON  |
|                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                       | D | LED Indicator 2 - OFF |
| 6                                                                                                                                                                                                                                                                                                                                                  | To develop a VI to communicate with programmable Instruments using Ethernet.                                                                                          |   |                       |
| 7                                                                                                                                                                                                                                                                                                                                                  | To develop a VI to interface USB DAQ 6008 with LabVIEW and perform the following Operations:<br>a. Analog Read<br>b. Analog Write<br>c. Digital Read<br>Digital Write |   |                       |
| 8                                                                                                                                                                                                                                                                                                                                                  | Time domain and frequency domain measurement of Real-world signal using LabVIEW                                                                                       |   |                       |
|                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                       |   |                       |
| PART: B - TYPICAL OPEN-ENDED EXPERIMENTS                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                       |   |                       |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                                                                                                       |   |                       |
| 1                                                                                                                                                                                                                                                                                                                                                  | Real Time Temperature measurement and Control using Virtual Instrumentation                                                                                           |   |                       |
| 2                                                                                                                                                                                                                                                                                                                                                  | Real time sequential control of bottle filling system                                                                                                                 |   |                       |
| 3                                                                                                                                                                                                                                                                                                                                                  | Design a real time batch processing using LabVIEW.                                                                                                                    |   |                       |
| 4                                                                                                                                                                                                                                                                                                                                                  | Design a PID controller using LabVIEW.                                                                                                                                |   |                       |

**Teaching & Learning Process (Innovative Delivery Methods):**

|   |                                      |
|---|--------------------------------------|
| 1 | Active Learning Techniques           |
| 2 | Problem-Based Learning (PBL)         |
| 3 | Team-Based Learning (TBL)            |
| 4 | Hands-On Experiments and Simulations |

**TEXT BOOKS:**

|   |                                                                                                                                                   |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Ministry of Education, Virtual Labs: An MHRD Govt of India Initiative. [Online]. Available: <a href="http://vlab.co.in/">http://vlab.co.in/</a> . |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------|

**e-LEARNING RESOURCES:**

|   |                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="http://vlab.amrita.edu">Network &amp; Circuits Electric Circuits Virtual Lab (Amrita/IITR) vlab.amrita.edu</a> |
|---|-------------------------------------------------------------------------------------------------------------------------|

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| Assessment Details both (CIE and SEE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                           |            |                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------|------------------------------------------------------------------------------|
| <p>The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.</p> <p><b>**Self-Study Component should be not included for SEE &amp; CIE.</b></p> |                                                           |            |                                                                              |
| CONTINUOUS INTERNAL EVALUATION (CIE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                           | Max. Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
| Laboratory components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Rubrics for each experiment are added, then taken average | 30         | 20                                                                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Lab CIE                                                   | 20         |                                                                              |
| TOTAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                           | 50         | 20                                                                           |

| Course Outcomes: After the completion of the course, the student will be able to: |                                                                                            |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| CO1                                                                               | Recognize the components of Virtual instrumentations and use them for PC Based Measurement |
| CO2                                                                               | Use and implement various types of structures used in LabVIEW                              |
| CO3                                                                               | Analyze and design different type of programs based on data acquisition.                   |
| CO4                                                                               | Create a VI system to solve real time problems.                                            |
| CO5                                                                               | Explore the LABVIEW and its Application in Various domine.                                 |

| Mapping of CO's, PO's with PSO's                                                                   |      |      |      |      |      |      |      |      |      |      |      |       |       |       |
|----------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |      |      |      |      |      |      |      |      |      |      |      |       |       |       |
| CO                                                                                                 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
| CO 1                                                                                               | 2    | -    | -    | -    | 3    | -    | -    | -    | 3    | 2    | 2    | 2     | 1     | 1     |
| CO 2                                                                                               | 2    | 2    | 2    | 2    | 3    | -    | -    | -    | 3    | 2    | 2    | 2     | 1     | 1     |
| CO 3                                                                                               | 2    | 2    | 2    | 2    | 3    | -    | -    | -    | 3    | 2    | 2    | 2     | 1     | 1     |
| CO 4                                                                                               | 2    | 2    | 1    | 2    | 3    | -    | -    | -    | 3    | 2    | 2    | 2     | 1     | 1     |
| CO 5                                                                                               | 2    | 2    | 1    |      | 2    |      |      |      |      |      | 2    | 1     |       |       |

| Mapping of CO's with Knowledge and Attitude Profile (WK)                                           |     |     |     |     |     |     |     |     |     |  |
|----------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |  |
| CO                                                                                                 | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |

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**Scheme: 2025**

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|            |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|
| <b>CO1</b> | 3 | 3 | 3 | 3 | 3 |   |   |   |   |
| <b>CO2</b> | 3 | 3 | 3 | 3 | 3 |   |   |   |   |
| <b>CO3</b> |   |   |   |   |   | 3 | 3 | 3 |   |
| <b>CO4</b> |   |   |   |   |   | 3 | 3 | 3 | 3 |
| <b>CO5</b> |   |   |   |   |   | 3 | 3 | 3 | 3 |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |           |
|-----------------------------------------------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0</b> |          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO/SDG</b>                                                                                             | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> | <b>17</b> |
| <b>CO1</b>                                                                                                |          |          |          | 3        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO2</b>                                                                                                |          |          |          | 3        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO3</b>                                                                                                |          |          |          | 3        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO4</b>                                                                                                |          |          |          | 3        |          |          |          | 2        |          |           |           |           |           | 2         | 2         |           |           |
| <b>CO5</b>                                                                                                |          |          |          | 3        |          |          |          | 2        |          |           |           |           |           | 2         | 2         |           |           |

**Course Coordinators:**

|                                                         |  |  |
|---------------------------------------------------------|--|--|
| Monika Shree T S,<br>Assistant Professor,<br><b>EIE</b> |  |  |
|---------------------------------------------------------|--|--|

**Heads of Programme:**

**Head of School**

Dr. Ganapathi. V Sagar  
Professor,  
Electronics and  
Instrumentation Engineering

Dr. H V Govindaraju ,  
Professor,  
School of Electrical, Electronics Sciences &  
Engineering, Dr. A.I.T

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
School of Electrical, Electronics Sciences & Engineering  
**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                                    |          |                              |          |              |                                |               |
|------------------------------------------------|----------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Circuit Simulation and PCB Lab</b>              |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL307D</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                           | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                           | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                               |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

| <b>Course Learning Objectives:</b> |                                                                                                                                                          |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| CLO1                               | The objective of Simulation laboratory is to impart hands on experience in verification of circuit laws and theorems, measurement of circuit parameters. |
| CLO2                               | Study of circuit characteristics using PSPICE                                                                                                            |
| CLO3                               | Understand the need for PCB Design and steps involved in PCB Design and Fabrication process.                                                             |

| <b>Syllabus</b>                                                                                                                                                                                         |                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                               |                                                                                                                                                                 |
| 1                                                                                                                                                                                                       | Simulation of RC and RL transient response (voltage and current in time domain) for varying component values to determine time constants.                       |
| 2                                                                                                                                                                                                       | Simulation of step response of a first-order system to analyze rise time and settling time characteristics.                                                     |
| 3                                                                                                                                                                                                       | Graphical modeling and simulation of second-order RLC networks to demonstrate overdamped, underdamped, critically damped, and undamped waveforms.               |
| 4                                                                                                                                                                                                       | Time-domain transient analysis of RC and RL circuits to verify theoretical behavior against simulated waveforms for different capacitor/inductor values.        |
| 5                                                                                                                                                                                                       | Simulation of an RLC network to visualize the physical damping effects and phase relationships between voltage and current.                                     |
| 6                                                                                                                                                                                                       | Characterization of a Practical Battery Source using Single sweep, DC sweep, and Parametric weep analysis to study internal resistance and load effects.        |
| 7                                                                                                                                                                                                       | Simulation of step response of first order system for different values of capacitor.                                                                            |
| 8                                                                                                                                                                                                       | Design and Simulation of Linear Regulated Power Supplies (using Zener Diodes and IC7805/IC7812) compared against unregulated outputs to calculate ripple factor |
| 9                                                                                                                                                                                                       | Design and Simulation of Dual Tracking Power Supplies (5V or 12V) using 78XX and 79XX series regulators for bipolar Op-Amp biasing.                             |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                         |                                                                                                                                                                 |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem |                                                                                                                                                                 |

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                                                                                                            |                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                                                                                                                         |
| 1                                                                                                                                          | Design and Simulation of a Precision Variable Power Supply using the LM317K regulator, evaluating line and load regulation over a specific voltage range.                               |
| 2                                                                                                                                          | Design and Simulation of a Three-Op-Amp Instrumentation Amplifier to evaluate Common Mode Rejection Ratio (CMRR) for differential inputs (e.g., $V_1=10\text{mV}$ , $V_2=5\text{mV}$ ). |
| 3                                                                                                                                          | Design and Simulation of an Instrumentation System interfaced with a Wheatstone Bridge to measure small changes in resistance (e.g., from a strain gauge or RTD).                       |
| 4                                                                                                                                          | Design, Simulation, and PCB Prototyping of a Buck Converter for an LED lighting system, including schematic capture and footprint assignment for fabrication.                           |

**Teaching & Learning Process (Innovative Delivery Methods):**

|   |                                      |
|---|--------------------------------------|
| 1 | Active Learning Techniques           |
| 2 | Problem-Based Learning (PBL)         |
| 3 | Team-Based Learning (TBL)            |
| 4 | Hands-On Experiments and Simulations |

**TEXT BOOKS:**

|   |                                                                                                                                                  |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | M. Affouf, Scilab by Example. Lexington, KY, USA: CreateSpace Independent Publishing Platform, 2012.                                             |
| 2 | M. H. Rashid, Introduction to PSpice Using OrCAD for Circuits and Electronics, 3rd ed. Upper Saddle River, NJ, USA: Pearson/Prentice Hall, 2004. |

**REFERENCE BOOKS:**

|   |                                                                                                                                                          |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | S. L. Campbell, J. Chancelier, and R. Nikoukhah, Modeling and Simulation in Scilab/Scicos with ScicosLab 4.4, 2nd ed. New York, NY, USA: Springer, 2010. |
| 2 | K. Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor. Burlington, MA, USA: Newnes,                                                         |

**e-LEARNING RESOURCES:**

|   |                                                                                                            |
|---|------------------------------------------------------------------------------------------------------------|
| 1 | Scilab Official Tutorials, <a href="https://www.scilab.org/tutorials">https://www.scilab.org/tutorials</a> |
| 2 | FOSSEE Scilab (IIT Bombay), <a href="https://scilab.in/">https://scilab.in/</a>                            |
| 3 | KiCad EDA Documentation, <a href="https://docs.kicad.org/">https://docs.kicad.org/</a>                     |
| 4 | MHRD Virtual Labs (Electric Circuits), <a href="http://vlab.co.in/">http://vlab.co.in/</a>                 |

**Assessment Details both (CIE and SEE)**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

**\*\*Self-Study Component should be not included for SEE & CIE.**

| CONTINUOUS INTERNAL EVALUATION (CIE) |                                                           | Max. Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|--------------------------------------|-----------------------------------------------------------|------------|------------------------------------------------------------------------------|
| Laboratory components                | Rubrics for each experiment are added, then taken average | 30         | 20                                                                           |
|                                      | Lab CIE                                                   | 20         |                                                                              |
| TOTAL                                |                                                           | 50         | 20                                                                           |

**Course Outcomes:** After the completion of the course, the student will be able to:

|     |                                                                                                                           |
|-----|---------------------------------------------------------------------------------------------------------------------------|
| CO1 | Model the transient and steady-state behavior of electrical and electronic circuits using SCILAB and XCOS                 |
| CO2 | Simulate the transient and steady-state behavior of electrical and electronic circuits using SCILAB and XCOS              |
| CO3 | Analyse the performance of first and second-order networks through mathematical Computation and circuit-level simulation. |
| CO4 | Design functional electric circuits and power systems using industry-standard EDA tools for PCB prototyping               |
| CO5 | Implement functional electric circuits and power systems using industry-standard EDA tools for PCB prototyping            |

#### Mapping of CO's, PO's with PSO's

**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO   | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO 1 | 2    | -    | -    | -    | 1    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| CO 2 | 2    | 2    | 2    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| CO 3 | 2    | 2    | 2    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| CO 4 | 2    | 2    | 1    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| CO 5 | 2    | 2    | 1    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |

#### Mapping of CO's with Knowledge and Attitude Profile (WK)

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
School of Electrical, Electronics Sciences & Engineering  
**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                                                                                                       | 2   | 2   | 2   | 2   | 2   |     |     |     |     |
| CO2                                                                                                       | -   | 2   | 2   | 2   | 2   |     |     |     |     |
| CO3                                                                                                       | -   | 2   | 2   | 2   | 2   |     |     |     |     |
| CO4                                                                                                       | -   | 2   | 2   | 2   | 2   |     |     |     |     |
| CO5                                                                                                       | -   | 2   | 2   | 2   | 2   |     |     |     |     |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CO1                                                                                                       |   |   |   | 2 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |
| CO2                                                                                                       |   |   |   | 1 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |
| CO3                                                                                                       |   |   |   | 1 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |
| CO4                                                                                                       | 1 |   |   | 1 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |
| CO5                                                                                                       | 1 |   |   | 1 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |

**Course Coordinators:**

|                                                    |  |  |
|----------------------------------------------------|--|--|
| Dr Sridevi N<br>Associate Professor,<br><b>EIE</b> |  |  |
|----------------------------------------------------|--|--|

**Heads of Programme:**

**Head of School**

Dr. Ganapathi. V Sagar  
Professor,  
Electronics and  
Instrumentation Engineering

Dr. H V Govindaraju ,  
Professor,  
School of Electrical, Electronics Sciences &  
Engineering, Dr. A.I.T

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
School of Electrical, Electronics Sciences & Engineering  
**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                       |          |                              |          |              |                                |               |
|------------------------------------------------|---------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Industrial Instrumentation</b>     |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIT404</b>                       |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>PCC (Professional Core Course)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                              | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | 3                                     | 0        | 0                            | 3        | 3            | 45+0+0+45=90                   | 3             |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                  |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

|                                    |                                                                                                  |
|------------------------------------|--------------------------------------------------------------------------------------------------|
| <b>Course Learning Objectives:</b> |                                                                                                  |
| CLO1                               | Comprehend various industrial instruments to enable continuous monitoring of process parameters. |
| CLO2                               | Understand industrial sensors and supporting systems.                                            |
| CLO3                               | Understand smart instrumentation methods to monitor the industrial parameters                    |

| <b>SYLLABUS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>No. of Hours</b> | <b>BTLs</b>  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------|
| <b>UNIT 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b>            | <b>L1-L2</b> |
| Flow Measurement: Introduction, Classification of Flow Meters, Head type flow meters – Orifice meter and Venturi tube, Rotameter, Electromagnetic Flow Meter, Ultrasonic flow meter, Laser anemometer, Rotor torque mass flow meter. Measurement of Force & Torque: Introduction, Force measuring sensor – Load cells – column type devices, proving rings, cantilever beam, Pressductor, Hydraulic load cell, Electronic weighing system. Torque measurement: Stress type & Deflection type.                                                                                                                                                                                                                 |                     |              |
| <b>Case Study:</b> Application considerations: selection, installation, calibration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |              |
| <b>UNIT 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b>            | <b>L1-L2</b> |
| Measurement of Pressure: Introduction, Diaphragms, Other elastic elements, Transduction methods – potentiometric device, strain gauge transducer, variable reluctance, LVDT type, variable capacitance device (principle, schematic & working, no derivation), force balance transducer (principle, schematic & working, no analysis), piezoelectric pressure transducer, pressure multiplexer, pressure calibration. Measurement of Sound, Speed and Thickness: Noise (sound) Sensors – nature of measurement, transducer principle, microphone types, Speed Sensors – tachometer generators, induction type, magnetic type, photoelectric type, Thickness Measurement – contact type and non-contact types. |                     |              |
| <b>Case Study:</b> selection, installation, calibration of Pressure measurement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |              |
| <b>UNIT 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b>            | <b>L1-L2</b> |
| Measurement of Level: Capacitance probes (bare & coated capacitance probe), Conductivity probes, Differential pressure level detector (force balance d/p cell), Float level devices (atmospheric tanks, rotameter type, mercury float switch, sump level), Optical level switches, Ultrasonic level detector (on-off & continues), Thermal level sensor. Measurement of Density: Definition & units of density and specific gravity, Liquid density measurement – Ball type, Capacitance type, Displacement type-chain balanced float, Hydrometers, Oscillating Coriolis, Radiation type, Sound velocity type. Gas density measurement – displacement type, electromagnetic suspension type.                  |                     |              |
| <b>Case Study:</b> selection, installation, calibration of Level measurement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |              |
| <b>UNIT 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b>            | <b>L1-L2</b> |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
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Viscosity Measurement: Definition and units, selection of viscometer, viscometer applications. Laboratory Viscometers – Capillary, capillary extrusion, Efflux cup (Saybolt viscometer), Falling ball, Rotational viscometer, Cone & plate viscometer. Industrial Viscometers - differential pressure continuous capillary viscometer, single and two float viscometer, vibrating reed viscometer. Turbidity: Definition, transmission type turbidity meter, light scattering turbidity meter.

**Case Study:** Application considerations: selection, installation, calibration

|               |          |              |
|---------------|----------|--------------|
| <b>UNIT 5</b> | <b>9</b> | <b>L1-L2</b> |
|---------------|----------|--------------|

Humidity Measurement: Definition and terminologies, dry and wet bulb psychrometers (Sling psychrometer), hair hygrometers, thin film capacitance humidity sensor, dew-point hygrometers, electrolytic hygrometers. Moisture Measurement: Definition and terminologies. Measurement of moisture in gases and liquids Electrolytic hygrometer, capacitance hygrometer, impedance hygrometer, piezoelectric hygrometer, infrared absorption hygrometer. Measurement of moisture in solids – Nuclear moisture gauge, infrared reflection moisture gauge, capacitance moisture gauge.

**Case Study: Sensor connectivity and protocols;** Sensor standards; Use cases: predictive maintenance, asset monitoring, safety and alarms;

**TEXT BOOKS:**

|   |                                                                                                                                                                                                   |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014. (Module 1 & Module 2 – Measurement of Pressure). |
| 2 | Process Measurement Instrument Engineers Handbook- Bela G. Liptak, Revised Edition, Chilton Book Company, 1982. [Module 2-Measurement of Sound, Speed and Thickness, Module 3 and 4]              |
| 3 | Industrial Instrumentation – K. Krishnaswamy and S. Vijayachitra, New Age International Pub., 2005. [Module 5]                                                                                    |

**REFERENCE BOOKS:**

|   |                                                                                                                                 |
|---|---------------------------------------------------------------------------------------------------------------------------------|
| 1 | Transducers and Instrumentation – D.V.S.Murty, 2nd Edition, PHI, 2009.                                                          |
| 2 | Introduction to Measurements and Instrumentation - A. K. Ghosh, 2nd Edition, PHI, 2007                                          |
| 3 | Instrumentation Measurement and Analysis- B.C.Nakra and K.K.Choudhry, 3rd Edition, McGraw Hill Education (India) Pvt.Ltd. 2009. |
| 4 | Measurement Systems Application and Design- Ernest O.Doeblin and Dhanesh N Manik, 5th Edition, McGraw Hill, 2007                |

**e-LEARNING RESOURCES:**

|   |                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://nptel.ac.in/courses/108105064">https://nptel.ac.in/courses/108105064</a>                               |
| 2 | <a href="https://onlinecourses.nptel.ac.in/noc21_ch26/preview">https://onlinecourses.nptel.ac.in/noc21_ch26/preview</a> |
|   | <a href="https://www.youtube.com/watch?v=1uPTYjxZzyo">https://www.youtube.com/watch?v=1uPTYjxZzyo</a>                   |
|   | <a href="https://nptel.ac.in/courses/103105130">https://nptel.ac.in/courses/103105130</a>                               |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

**CIE:** The CIE has three components – CIE - theory component, assignment and group activity. Students have to score a minimum of 40% Marks in the total of CIE - theory, assignment and group activity components put together to take SEE.

**SEE:** Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

**\*\*Self-Study Component should be not included for SEE & CIE.**

| CONTINUOUS INTERNAL EVALUATION (CIE) |                                          | Max. Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|--------------------------------------|------------------------------------------|------------|------------------------------------------------------------------------------|
| Theory                               | Weightage of CIE1 and CIE2 Tests or CIE3 | 50         | 20                                                                           |
| TOTAL                                |                                          | 50         | 20                                                                           |

#### QUESTION PAPER PATTERN (SEE)

| Q. No.                                                                                  | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
|-----------------------------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|-----|
| UNIT                                                                                    | 1  |    | 2  |    | 3  |    | 4  |    | 5  |     |
| 1. Two full questions (each of 20 Marks) are to be set from each unit.                  |    |    |    |    |    |    |    |    |    |     |
| 2. Student shall answer five full questions selecting one full question from each unit. |    |    |    |    |    |    |    |    |    |     |

**Course Outcomes:** After the completion of the course, the student will be able to:

|            |                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Discuss the principle, construction and working of transducers for the measurement of flow and force & torque.             |
| <b>CO2</b> | Explain the principle, construction and working of transducers for the measurement of pressure, sound, speed and thickness |
| <b>CO3</b> | Illustrate the principle, construction and working of transducers for the measurement of level and density                 |
| <b>CO4</b> | Discuss the principle, construction and working of transducers for the measurement of viscosity and turbidity              |
| <b>CO5</b> | Explain the principle, construction and working of transducers for the measurement of humidity and moisture.               |

#### Mapping of CO's, PO's with PSO's

**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3   | 1   |     |     |     |     |     | 1   | 1   |      | 2    | 2    | 2    |      |
| CO2 | 3   | 1   |     |     |     |     |     | 1   | 1   |      | 2    | 2    | 2    |      |
| CO3 | 3   | 1   |     |     |     |     |     | 1   | 1   |      | 2    | 2    | 2    |      |
| CO4 | 3   | 1   |     |     |     |     |     | 1   | 1   |      | 2    | 2    | 2    |      |
| CO5 | 3   | 1   |     |     |     |     |     | 1   | 1   |      | 2    | 2    | 2    |      |

#### Mapping of CO's with Knowledge and Attitude Profile (WK)

**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO  | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1 | 1   | 1   | 1   | 1   |     |     |     | 1   |     |
| CO2 | 1   | 1   | 1   | 1   |     |     |     | 1   |     |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
 School of Electrical, Electronics Sciences & Engineering  
**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|            |   |   |   |   |  |  |  |  |   |  |
|------------|---|---|---|---|--|--|--|--|---|--|
| <b>CO3</b> | 1 | 1 | 1 | 1 |  |  |  |  | 1 |  |
| <b>CO4</b> | 1 | 1 | 1 | 1 |  |  |  |  | 1 |  |
| <b>CO5</b> | 1 | 1 | 1 | 1 |  |  |  |  | 1 |  |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |           |
|-----------------------------------------------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0</b> |          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO/SDG</b>                                                                                             | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> | <b>17</b> |
| <b>CO1</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO2</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO3</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO4</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO5</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |

**Course Coordinators:**

|                                                    |  |  |
|----------------------------------------------------|--|--|
| Dr Sridevi N<br>Associate Professor,<br><b>EIE</b> |  |  |
|----------------------------------------------------|--|--|

**Heads of Programme:**

**Head of School**

Dr. Ganapathi. V Sagar  
 Professor,  
 Electronics and  
 Instrumentation Engineering

Dr. H V Govindaraju ,  
 Professor,  
 School of Electrical, Electronics Sciences &  
 Engineering, Dr. A.I.T

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|                                                |                                                   |          |                              |          |              |                                |               |
|------------------------------------------------|---------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Control Systems Lab</b>                        |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL405</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>PCCL (Professional Core Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                          | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                          | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                              |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

|                                    |                                                                                                                       |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Course Learning Objectives:</b> |                                                                                                                       |
| CLO1                               | To understand the operation of various circuits like sample and hold circuits, multiplexer and relay driving circuit. |
| CLO2                               | To design Lead and Lag compensating networks.                                                                         |
| CLO3                               | To analyze the performance of a second order control system in time domain and in frequency domain.                   |
| CLO4                               | To analyze the stability of the system.                                                                               |
| CLO5                               | Understand the effect of changing the design parameters on control system performance                                 |

| <b>Syllabus</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                          |                                                                                        |
| 1                                                                                                                                                                                                                                                                                                                                                  | Study the operation of Sample and Hold circuits using discrete components and IC.      |
| 2                                                                                                                                                                                                                                                                                                                                                  | Time Domain Analysis of Second Order System using discrete components                  |
| 3                                                                                                                                                                                                                                                                                                                                                  | Frequency response characteristics of Second Order System using discrete components    |
| 4                                                                                                                                                                                                                                                                                                                                                  | To study the operation of Unipolar and Bipolar analog Multiplexer.                     |
| 5                                                                                                                                                                                                                                                                                                                                                  | Verify the function of programmable gain amplifier using analog multiplexer            |
| 6                                                                                                                                                                                                                                                                                                                                                  | Design relay driving circuits using photo devices (LDR & Optocouplers).                |
| 7                                                                                                                                                                                                                                                                                                                                                  | To draw the frequency response characteristics of the lag and lead compensator network |
| 8                                                                                                                                                                                                                                                                                                                                                  | Design of state feedback controller                                                    |
| 9                                                                                                                                                                                                                                                                                                                                                  | Design of Full Order and Reduced Order Observer using MATLAB                           |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                    |                                                                                        |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                        |
| 1                                                                                                                                                                                                                                                                                                                                                  | Mathematical modelling of physical systems.                                            |
| 2                                                                                                                                                                                                                                                                                                                                                  | Comparative study of Bode, Nyquist and root locus with respect to stability.           |
| 3                                                                                                                                                                                                                                                                                                                                                  | Constant gain compensation in time and frequency domain                                |

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|   |                                                                                                                             |
|---|-----------------------------------------------------------------------------------------------------------------------------|
| 4 | Beyond the syllabus: Speed control of DC/ Servo motor control<br>Case study on Real time control of 2DOF helicopter control |
|---|-----------------------------------------------------------------------------------------------------------------------------|

| <b>Teaching &amp; Learning Process (Innovative Delivery Methods):</b> |                                      |
|-----------------------------------------------------------------------|--------------------------------------|
| 1                                                                     | Active Learning Techniques           |
| 2                                                                     | Problem-Based Learning (PBL)         |
| 3                                                                     | Team-Based Learning (TBL)            |
| 4                                                                     | Hands-On Experiments and Simulations |

| <b>TEXT BOOKS:</b> |                                                                                                                                                  |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                  | M. Affouf, Scilab by Example. Lexington, KY, USA: CreateSpace Independent Publishing Platform, 2012.                                             |
| 2                  | M. H. Rashid, Introduction to PSpice Using OrCAD for Circuits and Electronics, 3rd ed. Upper Saddle River, NJ, USA: Pearson/Prentice Hall, 2004. |

| <b>REFERENCE BOOKS:</b> |                                                                                                                                                          |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                       | S. L. Campbell, J. Chancelier, and R. Nikoukhah, Modeling and Simulation in Scilab/Scicos with ScicosLab 4.4, 2nd ed. New York, NY, USA: Springer, 2010. |
| 2                       | K. Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor. Burlington, MA, USA: Newnes,                                                         |

| <b>e-LEARNING RESOURCES:</b> |                                                                                                            |
|------------------------------|------------------------------------------------------------------------------------------------------------|
| 1                            | Scilab Official Tutorials, <a href="https://www.scilab.org/tutorials">https://www.scilab.org/tutorials</a> |
| 2                            | FOSSEE Scilab (IIT Bombay), <a href="https://scilab.in/">https://scilab.in/</a>                            |
| 3                            | KiCad EDA Documentation, <a href="https://docs.kicad.org/">https://docs.kicad.org/</a>                     |
| 4                            | MHRD Virtual Labs (Electric Circuits), <a href="http://vlab.co.in/">http://vlab.co.in/</a>                 |

| <b>Assessment Details both (CIE and SEE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                   |                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------|
| <p>The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.</p> <p><b>**Self-Study Component should be not included for SEE &amp; CIE.</b></p> |                   |                                                                              |
| <b>CONTINUOUS INTERNAL EVALUATION (CIE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Max. Marks</b> | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |

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|                              |                                                           |           |           |
|------------------------------|-----------------------------------------------------------|-----------|-----------|
| <b>Laboratory components</b> | Rubrics for each experiment are added, then taken average | <b>30</b> | <b>20</b> |
|                              | <b>Lab CIE</b>                                            | <b>20</b> |           |
| <b>TOTAL</b>                 |                                                           | <b>50</b> | <b>20</b> |

|                                                                                          |                                                                                             |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| <b>Course Outcomes:</b> After the completion of the course, the student will be able to: |                                                                                             |
| <b>CO1</b>                                                                               | Analyze the effect of sample and hold circuits, multiplexer and relay driving circuits.     |
| <b>CO2</b>                                                                               | Design and analyze Lead and Lag compensators for given specifications                       |
| <b>CO3</b>                                                                               | Perform time response and frequency analysis of a second order control system               |
| <b>CO4</b>                                                                               | Examine the stability criteria for a control system using root locus, Bode and Nyquist plot |
| <b>CO5</b>                                                                               | Examine the effect of changing the design parameters on control system performance          |

| <b>Mapping of CO's, PO's with PSO's</b>                                                                   |      |      |      |      |      |      |      |      |      |      |      |       |       |       |
|-----------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |      |      |      |      |      |      |      |      |      |      |      |       |       |       |
| CO                                                                                                        | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
| <b>CO 1</b>                                                                                               | 2    | -    | -    | -    | 1    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| <b>CO 2</b>                                                                                               | 2    | 2    | 2    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| <b>CO 3</b>                                                                                               | 2    | 2    | 2    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| <b>CO 4</b>                                                                                               | 2    | 2    | 1    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |
| <b>CO 5</b>                                                                                               | 2    | 2    | 1    | 2    | 3    | -    | -    | -    | 1    | 2    | 2    | 2     | 1     | 1     |

| <b>Mapping of CO's with Knowledge and Attitude Profile (WK)</b>                                           |     |     |     |     |     |     |     |     |     |  |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |  |
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| <b>CO1</b>                                                                                                | 2   | 2   | 2   | 2   | 2   |     |     |     |     |  |
| <b>CO2</b>                                                                                                | -   | 2   | 2   | 2   | 2   |     |     |     |     |  |
| <b>CO3</b>                                                                                                | -   | 2   | 2   | 2   | 2   |     |     |     |     |  |
| <b>CO4</b>                                                                                                | -   | 2   | 2   | 2   | 2   |     |     |     |     |  |
| <b>CO5</b>                                                                                                | -   | 2   | 2   | 2   | 2   |     |     |     |     |  |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| <b>CO1</b>                                                                                                |   |   |   | 2 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |
| <b>CO2</b>                                                                                                |   |   |   | 1 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |
| <b>CO3</b>                                                                                                |   |   |   | 1 |   |   | 1 |   | 1 |    |    |    |    |    |    |    |    |

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|            |   |  |  |   |  |  |   |  |   |  |  |  |  |  |  |  |  |
|------------|---|--|--|---|--|--|---|--|---|--|--|--|--|--|--|--|--|
| <b>CO4</b> | 1 |  |  | 1 |  |  | 1 |  | 1 |  |  |  |  |  |  |  |  |
| <b>CO5</b> | 1 |  |  | 1 |  |  | 1 |  | 1 |  |  |  |  |  |  |  |  |

**Course Coordinators:**

|                                                   |  |  |
|---------------------------------------------------|--|--|
| Dr Shubha P<br>Associate Professor,<br><b>EIE</b> |  |  |
|---------------------------------------------------|--|--|

**Heads of Programme**

**Head of School**

Dr. Ganapathi. V Sagar  
 Professor,  
 Electronics and  
 Instrumentation Engineering

Dr. H V Govindaraju ,  
 Professor,  
 School of Electrical, Electronics Sciences &  
 Engineering, Dr. A.I.T

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**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                                    |          |                              |          |              |                                |               |
|------------------------------------------------|----------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Programming in MATLAB/SCILAB/OCTAVE</b>         |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL406A</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                           | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                           | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                               |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

| <b>Course Learning Objectives:</b> |                                                                                                               |
|------------------------------------|---------------------------------------------------------------------------------------------------------------|
| CLO1                               | To provide knowledge of fundamental concepts of signals, systems, and signal processing techniques.           |
| CLO2                               | To develop practical skills in using computational tools for analysis and simulation of engineering problems. |
| CLO3                               | To understand the behavior and characteristics of continuous-time and discrete-time signals and systems.      |
| CLO4                               | To analyze signals and systems in time domain and frequency domain using mathematical techniques.             |
| CLO5                               | To enhance problem-solving and programming skills for engineering applications.                               |

| <b>Syllabus</b>                                                                                                                                                                                                                                                                                              |                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                                                                                                                                    |                                                                                                                                                                             |
| 1                                                                                                                                                                                                                                                                                                            | Basics Functions and Programming Environment of MATLAB/SCILAB/OCTAVE                                                                                                        |
| 2                                                                                                                                                                                                                                                                                                            | Programs on basic algebra functions                                                                                                                                         |
| 3                                                                                                                                                                                                                                                                                                            | Programs on basic operations of matrix                                                                                                                                      |
| 4                                                                                                                                                                                                                                                                                                            | Programs to plot different types of graphs                                                                                                                                  |
| 5                                                                                                                                                                                                                                                                                                            | Programs to Generate Continuous and Discrete Waveforms: (i) Step Function (ii) Impulse Function (iii) Exponential Function (iv) Ramp Function (v) Sine and Cosine functions |
| 6                                                                                                                                                                                                                                                                                                            | Programs to Perform Different Operations on Signals                                                                                                                         |
| 7                                                                                                                                                                                                                                                                                                            | Program to compute the frequency and power spectrum of time-domain signals using Fast Fourier Transform (FFT)                                                               |
| 8                                                                                                                                                                                                                                                                                                            | Programs to demonstrate amplitude & frequency Modulation                                                                                                                    |
| 9                                                                                                                                                                                                                                                                                                            | Program to Verify Sampling Theorem                                                                                                                                          |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                              |                                                                                                                                                                             |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical |                                                                                                                                                                             |

**Semester: III**

**Scheme: 2025**

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|                                       |                                                                                                                                                   |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| thinking, and inquiry-based learning. |                                                                                                                                                   |
| 1                                     | Program to Perform Convolution and Correlation of Two given Sequences.                                                                            |
| 2                                     | Program for the visualization of Gibbs phenomenon                                                                                                 |
| 3                                     | Z-Domain Analysis: Program to find the Z-transform and Inverse Z-transform of a sequence; simulate the Pole-Zero plot to analyze system stability |

**Teaching & Learning Process (Innovative Delivery Methods):**

|   |                                      |
|---|--------------------------------------|
| 1 | Active Learning Techniques           |
| 2 | Problem-Based Learning (PBL)         |
| 3 | Team-Based Learning (TBL)            |
| 4 | Hands-On Experiments and Simulations |

**TEXT BOOKS:**

|   |                                                                                                            |
|---|------------------------------------------------------------------------------------------------------------|
| 1 | MATLAB: A Practical Introduction to Programming and Problem Solving, Stormy Attaway, Academic Press, 2021. |
| 2 | Getting Started with MATLAB, RudraPratap, Oxford University Press, 2010.                                   |
| 3 | MATLAB Programming for Engineers, Stephen J. Chapman, Cengage Learning, 2018.                              |
| 4 | Introduction to SCILAB, Philippe Roux, Scilab Enterprises, 2016                                            |
| 5 | SCILAB by Example, M. Affouf, Createspace Independent Publishing, 2012                                     |
| 6 | GNU OCTAVE Beginner's Guide, JesúsRogel-Salazar, Packt Publishing, 2015                                    |

**REFERENCE BOOKS:**

|   |                                                                                                                              |
|---|------------------------------------------------------------------------------------------------------------------------------|
| 1 | V. Oppenheim, A. S. Willsky, and S. H. Nawab, Signals and Systems, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 1996. |
| 2 | S. Haykin and B. Van Veen, Signals and Systems, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2007                            |

**e-LEARNING RESOURCES:**

|   |                                                                                                                                                      |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | NPTEL: Signals and Systems <a href="https://nptel.ac.in/courses/108104100">https://nptel.ac.in/courses/108104100</a>                                 |
| 2 | MIT OpenCourseWare (6.003) <a href="https://ocw.mit.edu/courses/6-003-signals-and-systems">https://ocw.mit.edu/courses/6-003-signals-and-systems</a> |
| 3 | FOSSEE Scilab Textbook Companion <a href="https://scilab.in/textbook_companion">https://scilab.in/textbook_companion</a>                             |
| 4 | GNU Octave (Open Source Tool) <a href="https://www.gnu.org/software/octave/">https://www.gnu.org/software/octave/</a>                                |

**Assessment Details both (CIE and SEE)**

**Semester: III**

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The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

**\*\*Self-Study Component should be not included for SEE & CIE.**

| CONTINUOUS INTERNAL EVALUATION (CIE) |                                                           | Max. Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|--------------------------------------|-----------------------------------------------------------|------------|------------------------------------------------------------------------------|
| Laboratory components                | Rubrics for each experiment are added, then taken average | 30         | 20                                                                           |
|                                      | Lab CIE                                                   | 20         |                                                                              |
| TOTAL                                |                                                           | 50         | 20                                                                           |

**Course Outcomes:** After the completion of the course, the student will be able to:

|     |                                                                                                                                |
|-----|--------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Use scripts and functions in developing simple programs in MATLAB/SCILAB/OCTAVE                                                |
| CO2 | Use arrays, vectors and matrices in developing programs in MATLAB/SCILAB/ OCTAVE                                               |
| CO3 | Solve algebraic equations, generate discrete waveforms and perform different operations on signals using MATLAB/SCILAB/ OCTAVE |
| CO4 | Apply commands in plotting the graphs for various functions using the MATLAB/SCILAB/ OCTAVE interface                          |
| CO5 | Develop MATLAB/SCILAB/ OCTAVE programming skills and techniques to solve mathematical and engineering problems                 |

#### Mapping of CO's, PO's with PSO's

**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO   | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO 1 | 3    | 2    | 1    | 1    | 3    |      |      |      | 1    | 1    | 1    |       |       | 3     |
| CO 2 | 3    | 2    | 1    | 2    | 3    |      |      |      | 1    | 1    | 1    |       |       | 3     |
| CO 3 | 3    | 3    | 2    | 3    | 3    |      |      |      | 1    | 1    | 1    |       |       | 3     |
| CO 4 | 2    | 2    | 1    | 2    | 3    |      |      |      | 1    | 1    | 1    |       |       | 3     |
| CO 5 | 3    | 3    | 3    | 3    | 3    |      |      |      | 1    | 2    | 2    |       |       | 3     |

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| <b>Mapping of CO's with Knowledge and Attitude Profile (WK)</b>                                           |     |     |     |     |     |     |     |     |     |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                                                                                                       | 3   | 2   | 2   |     | 2   |     |     |     |     |
| CO2                                                                                                       | 3   | 3   | 2   |     | 2   |     |     |     |     |
| CO3                                                                                                       | 3   | 3   | 3   | 2   | 2   |     |     |     |     |
| CO4                                                                                                       | 2   | 2   | 2   | 2   | 2   |     |     |     |     |
| CO5                                                                                                       | 3   | 3   | 3   | 3   | 3   |     |     |     |     |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|-----------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                                    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CO1                                                                                                       |   |   |   | 3 |   |   |   | 2 | 2 |    |    |    |    |    |    |    |    |
| CO2                                                                                                       |   |   |   | 3 |   |   |   | 2 | 3 |    |    |    |    |    |    |    |    |
| CO3                                                                                                       |   |   |   | 2 |   |   | 2 | 2 | 3 |    |    | 2  |    |    |    |    |    |
| CO4                                                                                                       |   |   |   | 2 |   |   |   | 2 | 3 |    |    | 2  |    |    |    |    |    |
| CO5                                                                                                       |   |   |   | 3 |   |   | 2 | 3 | 3 |    |    | 2  | 2  |    |    |    |    |

**Course Coordinators:**

|                                                   |  |  |
|---------------------------------------------------|--|--|
| Dr Shubha P<br>Associate Professor,<br><b>EIE</b> |  |  |
|---------------------------------------------------|--|--|

**Heads of Programme**

Dr. Ganapathi. V Sagar  
Professor,  
Electronics and Instrumentation  
Engineering

**Head of School**

Dr. H V Govindaraju ,  
Professor,  
School of Electrical, Electronics Sciences &  
Engineering, Dr. A.I.T

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
School of Electrical, Electronics Sciences & Engineering  
**Program: Electronics and Instrumentation Engineering**

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                                    |          |                              |          |              |                                |               |
|------------------------------------------------|----------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Internet of Things (IoT) Lab</b>                |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL406B</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                           | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                           | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                               |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

|                                    |                                                                                                                                   |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| <b>Course Learning Objectives:</b> |                                                                                                                                   |
| CLO1                               | To demonstrate the ability to interface sensors and actuators with microcontroller platform.                                      |
| CLO2                               | To implement IoT based system using communication protocols                                                                       |
| CLO3                               | To expose students to modern IoT and cloud-based monitoring systems by integrating sensor data with platforms such as ThingSpeak. |

| <b>Syllabus</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                          |                                                                                                                              |
| 1                                                                                                                                                                                                                                                                                                                                                  | Controlling the LED blink rate with the potentiometer interfacing with Arduino                                               |
| 2                                                                                                                                                                                                                                                                                                                                                  | Interfacing Servo Motor with the Arduino                                                                                     |
| 3                                                                                                                                                                                                                                                                                                                                                  | Burglar alarm security system with the help of PIR sensor and buzzer using Arduino                                           |
| 4                                                                                                                                                                                                                                                                                                                                                  | To detect the touch sense for ESP32 and control led                                                                          |
| 5                                                                                                                                                                                                                                                                                                                                                  | Publish Sensor Readings on Google Sheets using ESP32.                                                                        |
| 6                                                                                                                                                                                                                                                                                                                                                  | To used ADC of ESP32 to display digital output of analog sensor.                                                             |
| 7                                                                                                                                                                                                                                                                                                                                                  | Automatic Identification Based on IR sensor, Ultrasonic sensor                                                               |
| 8                                                                                                                                                                                                                                                                                                                                                  | Acquired Analog Sensor signal data (LDR/DHT11) and display on LCD                                                            |
| 9                                                                                                                                                                                                                                                                                                                                                  | Upload humidity & temperature data to Thing Speak                                                                            |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                    |                                                                                                                              |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                                                              |
| 1                                                                                                                                                                                                                                                                                                                                                  | Hosting a basic server from the ESP32 to control various digital based actuators (led, buzzer, relay) from a simple web page |
| 2                                                                                                                                                                                                                                                                                                                                                  | To set a rising edge-interrupt on the GPIO pin of ESP32.                                                                     |
| 3                                                                                                                                                                                                                                                                                                                                                  | Soil Moisture Sensor Interfacing with ESP32 to measures the volumetric water content in soil                                 |

|                                                                       |                                      |
|-----------------------------------------------------------------------|--------------------------------------|
| <b>Teaching &amp; Learning Process (Innovative Delivery Methods):</b> |                                      |
| 1                                                                     | Active Learning Techniques           |
| 2                                                                     | Problem-Based Learning (PBL)         |
| 3                                                                     | Team-Based Learning (TBL)            |
| 4                                                                     | Hands-On Experiments and Simulations |

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
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**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

| <b>TEXT BOOKS:</b> |                                                                                                  |
|--------------------|--------------------------------------------------------------------------------------------------|
| 1                  | Internet of Things: A Hands-on Approach by Vijay Madisetti and ArshdeepBahga (University Press). |

| <b>REFERENCE BOOKS:</b>      |                                                                                                                         |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 1                            | Introduction to Internet of Things: A Practical Approach by Dr. SRN Reddy, RachitThukral, and Manasi Mishra (ETI Labs). |
| 2                            | The Internet of Things: Enabling Technologies, Platforms, and Use Cases by Pethuru Raj and Anupama C Raman (CRC Press)  |
| <b>e-LEARNING RESOURCES:</b> |                                                                                                                         |
| 1                            | <a href="https://www.vlab.co.in/">https://www.vlab.co.in/</a>                                                           |
| 2                            | Videos and Lecture Notes: <a href="http://www.nptel.ac.in">http://www.nptel.ac.in</a>                                   |

| <b>Assessment Details both (CIE and SEE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                           |                   |                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-------------------|------------------------------------------------------------------------------|
| <p>The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.</p> <p><b>**Self-Study Component should be not included for SEE &amp; CIE.</b></p> |                                                           |                   |                                                                              |
| <b>CONTINUOUS INTERNAL EVALUATION (CIE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                           | <b>Max. Marks</b> | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
| <b>Laboratory components</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Rubrics for each experiment are added, then taken average | <b>30</b>         | <b>20</b>                                                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Lab CIE</b>                                            | <b>20</b>         |                                                                              |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                           | <b>50</b>         | <b>20</b>                                                                    |

| <b>Course Outcomes:</b> After the completion of the course, the student will be able to: |                                                                                                                                                                |
|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>                                                                               | Demonstrate the use of Arduino/microcontroller hardware and IDE to interface digital and analog sensors                                                        |
| <b>CO2</b>                                                                               | Configure WiFi-enabled IoT boards (ESP8266/ESP32) and explore different functionalities of microcontroller board                                               |
| <b>CO3</b>                                                                               | Develop and upload embedded C/C++ programs to control actuators (relay, servo, buzzer, LED) based on sensor inputs and defined logic/thresholds                |
| <b>CO4</b>                                                                               | Visualize the sensor data report on cloud-based platform and control devices                                                                                   |
| <b>CO5</b>                                                                               | Integrate multiple sensors, actuators, and communication protocols to design and implement a functional IoT-based project addressing a real-world application. |

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**Scheme: 2025**

**Academic Year: 2026-27**

| Mapping of CO's, PO's with PSO's                                                                   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|----------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO                                                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                | 3   | 2   | 2   | 1   | 2   |     |     |     |     |      |      | 1    | 1    | 2    |
| CO2                                                                                                | 3   | 2   | 2   | 2   | 2   |     |     |     |     |      |      | 1    | 2    | 2    |
| CO3                                                                                                | 3   | 2   | 2   | 1   | 2   | 2   |     |     | 1   | 1    | 2    | 1    | 2    | 2    |
| CO4                                                                                                | 3   | 2   | 2   | 2   | 2   | 2   |     |     | 1   | 2    | 2    | 1    | 2    | 3    |
| CO5                                                                                                | 3   | 2   | 2   | 1   | 2   | 2   |     |     | 2   | 1    | 1    | 1    | 2    | 3    |

| Mapping of CO's with Knowledge and Attitude Profile (WK)                                           |     |     |     |     |     |     |     |     |     |
|----------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |
| CO                                                                                                 | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                                                                                                | 1   | 1   | 2   | 2   | 1   | 3   |     |     |     |
| CO2                                                                                                |     | 1   | 2   | 3   | 1   | 3   | 1   |     |     |
| CO3                                                                                                | 1   | 1   | 2   | 2   | 2   | 3   |     |     |     |
| CO4                                                                                                |     | 1   | 1   | 3   | 2   | 3   | 2   | 1   | 1   |
| CO5                                                                                                | 1   | 1   | 2   | 3   | 3   | 3   | 2   | 1   | 1   |

| Mapping of CO's with Sustainable Development Goals (SDG)                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|----------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                             | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CO1                                                                                                |   |   |   | 1 |   |   |   |   | 2 |    |    |    |    |    |    |    |    |
| CO2                                                                                                |   |   |   | 1 |   |   |   |   | 2 |    | 1  |    |    |    |    |    |    |
| CO3                                                                                                |   |   |   | 1 |   |   | 1 | 1 | 2 |    |    | 1  |    |    |    |    |    |
| CO4                                                                                                |   |   |   | 1 |   |   | 1 | 1 | 3 |    | 2  | 1  |    |    |    |    | 1  |
| CO5                                                                                                |   | 1 | 1 | 1 |   | 2 | 2 | 2 | 3 |    | 2  | 2  | 1  |    | 1  |    | 1  |

**Course Coordinators:**

|                                                |  |  |
|------------------------------------------------|--|--|
| Mrs. Soumya B S<br>Assistant Professor,<br>EIE |  |  |
|------------------------------------------------|--|--|

**Heads of Programme**

**Head of School**

Dr. Ganapathi. V Sagar  
Professor,  
Electronics and  
Instrumentation Engineering

Dr. H V Govindaraju ,  
Professor,  
School of Electrical, Electronics Sciences &  
Engineering, Dr. A.I.T

**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                                    |          |                              |          |              |                                |               |
|------------------------------------------------|----------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Advanced Verilog Programming Lab</b>            |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL406C</b>                                   |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b> |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                           | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                           | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                               |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

|                                    |                                                              |
|------------------------------------|--------------------------------------------------------------|
| <b>Course Learning Objectives:</b> |                                                              |
| CLO1                               | Familiarize with the CAD tool to write HDL programs.         |
| CLO2                               | Understand simulation and synthesis of digital design.       |
| CLO3                               | Program FPGAs/CPLDs to synthesize the digital designs        |
| CLO4                               | Interface hardware to programmable ICs through I/O ports.    |
| CLO5                               | Choose either Verilog or VHDL for a given Abstraction level. |

| <b>Syllabus</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                          |                                                                                                                             |
| 1                                                                                                                                                                                                                                                                                                                                                  | Write a Verilog code to implement a stack calculator using a memory module (block RAM on the FPGA) and the board I/O.       |
| 2                                                                                                                                                                                                                                                                                                                                                  | Verilog programs to interface Switches and LEDs to the FPGA/CPLD and demonstrate its working.                               |
| 3                                                                                                                                                                                                                                                                                                                                                  | Verilog Program to interface a Stepper motor to the FPGA/CPLD and rotate the motor in the specified direction (by N steps). |
| 4                                                                                                                                                                                                                                                                                                                                                  | Verilog Code for Instruction Memory                                                                                         |
| 5                                                                                                                                                                                                                                                                                                                                                  | Verilog code for 16-bit single-cycle MIPS processor                                                                         |
| 6                                                                                                                                                                                                                                                                                                                                                  | License Plate Recognition in Verilog HDL                                                                                    |
| 7                                                                                                                                                                                                                                                                                                                                                  | How to load a text file into FPGA using Verilog HDL                                                                         |
| 8                                                                                                                                                                                                                                                                                                                                                  | Verilog code for Traffic Light Controller                                                                                   |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                    |                                                                                                                             |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                                                             |
| 1                                                                                                                                                                                                                                                                                                                                                  | Verilog code for PWM Generator                                                                                              |
| 2                                                                                                                                                                                                                                                                                                                                                  | Verilog code for counter                                                                                                    |
| 3                                                                                                                                                                                                                                                                                                                                                  | Design a finite state machine in Verilog to detect the given sequence of bits.                                              |
| 4                                                                                                                                                                                                                                                                                                                                                  | Write Verilog code using FSM to simulate elevator operation                                                                 |

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**Scheme: 2025**

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| <b>Teaching &amp; Learning Process</b> (Innovative Delivery Methods): |                                      |
|-----------------------------------------------------------------------|--------------------------------------|
| 1                                                                     | Active Learning Techniques           |
| 2                                                                     | Problem-Based Learning (PBL)         |
| 3                                                                     | Team-Based Learning (TBL)            |
| 4                                                                     | Hands-On Experiments and Simulations |

| <b>TEXT BOOKS:</b> |                                                                                                                       |
|--------------------|-----------------------------------------------------------------------------------------------------------------------|
| 1                  | NazeihM.Botros, 2009 reprint, Dreamtech press(units 1,2,3,4,5-verilog description) “HDL Programming VHDL and Verilog” |
| 2                  | Charles H Roth, Jr Cengage learning “Fundamentals of logic Design”,                                                   |

| <b>REFERENCE BOOKS:</b>      |                                                                                           |
|------------------------------|-------------------------------------------------------------------------------------------|
| 1                            | Douglas perry-Tata McGraw-Hill 4 <sup>th</sup> edition 2004 “VHDL: Programming Examples”- |
| <b>e-LEARNING RESOURCES:</b> |                                                                                           |
|                              |                                                                                           |

| <b>Assessment Details both (CIE and SEE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                           |                   |                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-------------------|------------------------------------------------------------------------------|
| <p>The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.</p> <p><b>**Self-Study Component should be not included for SEE &amp; CIE.</b></p> |                                                           |                   |                                                                              |
| <b>CONTINUOUS INTERNAL EVALUATION (CIE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                           | <b>Max. Marks</b> | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
| <b>Laboratory components</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Rubrics for each experiment are added, then taken average | <b>30</b>         | <b>20</b>                                                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Lab CIE</b>                                            | <b>20</b>         |                                                                              |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                           | <b>50</b>         | <b>20</b>                                                                    |

| <b>Course Outcomes:</b> After the completion of the course, the student will be able to: |                                                                                                                   |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>                                                                               | Understand the basics of Hardware Description Languages, Program structure and basic language elements of Verilog |

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**Semester: III**

**Scheme: 2025**

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|            |                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------|
| <b>CO2</b> | Understand types of modelling, modules, functions of Verilog and simulate and synthesize related Programs. |
| <b>CO3</b> | Design, Simulate and Synthesize various Verilog descriptions for Combinational circuits.                   |
| <b>CO4</b> | Design, Simulate and Synthesize various Verilog descriptions for Sequential circuits.                      |

| <b>Mapping of CO's, PO's with PSO's</b>                                                                   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO                                                                                                        | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                       | 3   | 2   |     |     | 2   |     |     |     |     |      | 1    |      | 2    | 3    |
| CO2                                                                                                       | 3   | 2   | 2   | 1   | 3   |     |     |     |     |      | 1    |      | 2    | 3    |
| CO3                                                                                                       | 3   | 3   | 3   | 2   | 3   |     |     |     |     |      | 1    |      | 2    | 3    |
| CO4                                                                                                       | 3   | 3   | 3   | 2   | 3   |     |     |     |     |      | 1    |      | 2    | 3    |

| <b>Mapping of CO's with Knowledge and Attitude Profile (WK)</b>                                           |     |     |     |     |     |     |     |     |     |   |
|-----------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| <b>Strength of correlation:</b> Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |     |     |     |     |     |     |     |     |     |   |
| CO                                                                                                        | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |   |
| CO1                                                                                                       | 3   | 3   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0 |
| CO2                                                                                                       | 0   | 3   | 3   | 3   | 0   | 0   | 0   | 0   | 0   | 0 |
| CO3                                                                                                       | 0   | 0   | 3   | 3   | 3   | 0   | 0   | 0   | 0   | 0 |
| CO4                                                                                                       | 0   | 0   | 3   | 3   | 3   | 0   | 0   | 0   | 0   | 0 |

| Mapping of CO's with Sustainable Development Goals (SDG)                                           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
|----------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|
| Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0 |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |
| CO/SDG                                                                                             | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| CO1                                                                                                |   |   |   | 3 |   |   |   |   | 1 |    |    |    |    |    |    |    |    |
| CO2                                                                                                |   |   |   | 3 |   |   |   |   | 3 |    |    |    |    |    |    |    |    |
| CO3                                                                                                |   |   |   | 2 |   |   |   |   | 3 |    |    | 1  |    |    |    |    |    |
| CO4                                                                                                |   |   |   | 2 |   |   |   |   | 3 |    |    | 2  |    |    |    |    |    |

**Course Coordinators:**

|                                                      |  |  |
|------------------------------------------------------|--|--|
| Mrs. Sheetal N<br>Assistant Professor,<br><b>EIE</b> |  |  |
|------------------------------------------------------|--|--|

**Heads of Programme:**

**Head of School**

Dr. Ganapathi. V Sagar  
Professor,  
Electronics and  
Instrumentation Engineering

Dr. H V Govindaraju ,  
Professor,  
School of Electrical, Electronics Sciences &  
Engineering, Dr. A.I.T

Dr. Ambedkar Institute of Technology, Bengaluru - 560056  
School of Electrical, Electronics Sciences & Engineering  
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**Semester: III**

**Scheme: 2025**

**Academic Year: 2026-27**

|                                                |                                                      |          |                              |          |              |                                |               |
|------------------------------------------------|------------------------------------------------------|----------|------------------------------|----------|--------------|--------------------------------|---------------|
| <b>Course Title</b>                            | <b>Intelligent Sensing &amp; Instrumentation Lab</b> |          |                              |          |              |                                |               |
| <b>Course Code</b>                             | <b>1BEIL406D</b>                                     |          |                              |          |              |                                |               |
| <b>Course Category</b>                         | <b>AEC (Ability Enhancement Course Laboratory)</b>   |          |                              |          |              |                                |               |
| <b>Teaching - Learning Scheme &amp; Credit</b> | <b>L</b>                                             | <b>T</b> | <b>P</b>                     | <b>S</b> | <b>Total</b> | <b>Total Teaching Hours</b>    | <b>Credit</b> |
|                                                | <b>0</b>                                             | <b>0</b> | <b>30</b>                    | <b>0</b> | <b>30</b>    | <b>30</b>                      | <b>1</b>      |
| <b>CIE Marks: 50</b>                           | <b>SEE Marks: 50</b>                                 |          | <b>Total Max. Marks: 100</b> |          |              | <b>Duration of SEE: 03 Hrs</b> |               |

|                                    |                                                                                                  |
|------------------------------------|--------------------------------------------------------------------------------------------------|
| <b>Course Learning Objectives:</b> |                                                                                                  |
| CLO1                               | Comprehend various industrial instruments to enable continuous monitoring of process parameters. |
| CLO2                               | Understand industrial sensors and supporting systems.                                            |
| CLO3                               | Understand smart instrumentation methods to monitor the industrial parameters                    |

| <b>Syllabus</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PART: A - CONVENTIONAL EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                     |
| 1                                                                                                                                                                                                                                                                                                                                                  | Industrial Temperature Sensing: Study the characteristics of RTD, Thermocouple, and Thermistor. Design and simulate the analog signal conditioning circuits (bridges/amplifiers) to make them suitable for a 0–5V controller input. |
| 2                                                                                                                                                                                                                                                                                                                                                  | Force and Strain Measurement: Characterize a Load Cell and Strain Gauge using a Wheatstone Bridge. Perform linearization and calibration to map voltage output to physical weight/strain units.                                     |
| 3                                                                                                                                                                                                                                                                                                                                                  | Position and Light Sensing: Study the characteristics of LVDT (Linear Variable Differential Transformer) and LDR (Light Dependent Resistor). Implement a VI to display displacement and lux levels.                                 |
| 4                                                                                                                                                                                                                                                                                                                                                  | Virtual Instrumentation (VI) Logic: Develop LabVIEW algorithms using Structures (For/While loops, Case, Sequence) and Sub-VIs to implement digital logic (e.g., a Full Adder or an 8:1 Mux).                                        |
| 5                                                                                                                                                                                                                                                                                                                                                  | Data Management (Arrays & Strings): Build a VI to process sensor data in Arrays (sorting, min/max, finding odd/even) and implement a secure access system using String/File I/O (Username/Password validation).                     |
| 6                                                                                                                                                                                                                                                                                                                                                  | Data Acquisition (DAQ) Fundamentals: Perform finite and continuous buffered acquisition using DAQ cards. Configure Analog Input/Output and Digital I/O channels to interface external hardware with the LabVIEW environment.        |
| 7                                                                                                                                                                                                                                                                                                                                                  | Real-Time Data Acquisition (DAQ): Implement finite and continuous buffered acquisition modes using DAQ cards. Configure and verify Analog Input, Digital I/O, and Analog Output for physical sensor interfacing..                   |
| 8                                                                                                                                                                                                                                                                                                                                                  | Smart System Identification: Build a VI to simulate and study the performance of First-order and Second-order systems. Determine the time constant, damping ratio, and settling time from step response data.                       |
| <b>PART: B - TYPICAL OPEN-ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                     |
| Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. |                                                                                                                                                                                                                                     |

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|   |                                                                                                                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Intelligent Controller Design: Design and implement a Discrete/Continuous PID Controller in LabVIEW to regulate a process variable (e.g., Temperature or Motor Speed). Compare the performance of P, PI, and PID modes. |
| 2 | Signal Processing & Spectrum Analysis: Develop a VI for different wave generation (Sine, Square, Triangle). Apply FFT algorithms for frequency detection and generate an automated HTML report of the findings.         |
| 3 | Automated Industrial Reporting: Create a system that monitors multi-sensor data and automatically generates an HTML/Spreadsheet report based on specific trigger events (e.g., an "Out of Bounds" alarm).               |
| 4 | Controller Implementation: Design and implement Discrete and Continuous controllers (e.g., ON-OFF or Proportional) using discrete analog components and LabVIEW simulation to observe closed-loop stability.            |

**Teaching & Learning Process (Innovative Delivery Methods):**

|   |                                      |
|---|--------------------------------------|
| 1 | Active Learning Techniques           |
| 2 | Problem-Based Learning (PBL)         |
| 3 | Team-Based Learning (TBL)            |
| 4 | Hands-On Experiments and Simulations |

**TEXT BOOKS:**

|   |                                                                                                |
|---|------------------------------------------------------------------------------------------------|
| 1 | J. Jerome, Virtual Instrumentation using LabVIEW. New Delhi, India: PHI Learning, 2010.        |
| 2 | D. V. S. Murty, Transducers and Instrumentation, 2nd ed. New Delhi, India: PHI Learning, 2010. |

**REFERENCE BOOKS:**

|   |                                                                                                                                                        |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | R. H. Bishop, Learning with LabVIEW. Upper Saddle River, NJ, USA: Pearson/Prentice Hall, 2015. 2. B. G. Liptak, Instrument Engineers' Handbook, Volume |
| 2 | Process Control and Optimization, 4th ed. Boca Raton, FL, USA: CRC Press, 2005.                                                                        |

**e-LEARNING RESOURCES:**

|   |                                                                                                                                               |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | NPTEL, "Industrial Instrumentation," IIT Kharagpur. <a href="https://nptel.ac.in/courses/108105064">https://nptel.ac.in/courses/108105064</a> |
| 2 | National Instruments, "LabVIEW Core 1 & 2 Self-Paced Training." <a href="https://learn.ni.com/training">https://learn.ni.com/training</a>     |
| 3 | MIT OpenCourseWare, "Introduction to Instrumentation and Measurement." <a href="https://ocw.mit.edu/">https://ocw.mit.edu/</a>                |

**Assessment Details both (CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. CIE: The CIE has two components – CIE - theory component and CIE – laboratory component.

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Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.

Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

**\*\*Self-Study Component should be not included for SEE & CIE.**

| CONTINUOUS INTERNAL EVALUATION (CIE) |                                                           | Max. Marks | Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually) |
|--------------------------------------|-----------------------------------------------------------|------------|------------------------------------------------------------------------------|
| Laboratory components                | Rubrics for each experiment are added, then taken average | 30         | 20                                                                           |
|                                      | Lab CIE                                                   | 20         |                                                                              |
| TOTAL                                |                                                           | 50         | 20                                                                           |

**Course Outcomes:** After the completion of the course, the student will be able to:

|     |                                                                                                                            |
|-----|----------------------------------------------------------------------------------------------------------------------------|
| CO1 | Discuss the principle, construction and working of transducers for the measurement of flow and force & torque.             |
| CO2 | Explain the principle, construction and working of transducers for the measurement of pressure, sound, speed and thickness |
| CO3 | Illustrate the principle, construction and working of transducers for the measurement of level and density                 |
| CO4 | Discuss the principle, construction and working of transducers for the measurement of viscosity and turbidity              |
| CO5 | Explain the principle, construction and working of transducers for the measurement of humidity and moisture.               |

**Mapping of CO's, PO's with PSO's**

**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO   | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO 1 | 3    | 1    |      |      |      |      |      | 1    | 1    |      | 2    | 2     | 2     |       |
| CO 2 | 3    | 1    |      |      |      |      |      | 1    | 1    |      | 2    | 2     | 2     |       |
| CO 3 | 3    | 1    |      |      |      |      |      | 1    | 1    |      | 2    | 2     | 2     |       |
| CO 4 | 3    | 1    |      |      |      |      |      | 1    | 1    |      | 2    | 2     | 2     |       |
| CO 5 | 3    | 1    |      |      |      |      |      | 1    | 1    |      | 2    | 2     | 2     |       |

**Mapping of CO's with Knowledge and Attitude Profile (WK)**

**Strength of correlation:** Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

| CO  | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1 | 1   | 1   | 1   | 1   |     |     |     | 1   |     |
| CO2 | 1   | 1   | 1   | 1   |     |     |     | 1   |     |
| CO3 | 1   | 1   | 1   | 1   |     |     |     | 1   |     |

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|            |   |   |   |   |  |  |  |  |   |  |
|------------|---|---|---|---|--|--|--|--|---|--|
| <b>CO4</b> | 1 | 1 | 1 | 1 |  |  |  |  | 1 |  |
| <b>CO5</b> | 1 | 1 | 1 | 1 |  |  |  |  | 1 |  |

| <b>Mapping of CO's with Sustainable Development Goals (SDG)</b>                                           |          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |           |
|-----------------------------------------------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0</b> |          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO/SDG</b>                                                                                             | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> | <b>17</b> |
| <b>CO1</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO2</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO3</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO4</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |
| <b>CO5</b>                                                                                                | 1        | 1        |          | 1        |          |          |          |          |          |           |           |           |           |           |           |           |           |

**Course Coordinators:**

|                                                      |                                                                    |  |
|------------------------------------------------------|--------------------------------------------------------------------|--|
| Mrs. Sheetal N<br>Assistant Professor,<br><b>EIE</b> | <b>Mr. Sridhar Kumar H R</b><br>Assistant Professor,<br><b>EIE</b> |  |
|------------------------------------------------------|--------------------------------------------------------------------|--|

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