

**COEP Technological University Pune  
(A Unitary Public University of Govt. of Maharashtra)**

**School of Engineering and Technology**

Curriculum Structure & Detailed Syllabus

**T. Y. B. Tech.**

**Instrumentation and Control Engineering**

**(Effective from: A.Y. 2026-27)**

### **Program Educational Objectives (PEOs)**

After the completion of the program,

- I.** Student will be employable in the diversified sectors of the industry, government organizations, public sector and research organizations.
- II.** Student will pursue higher education in engineering or other fields of their interests, at institutes of repute and high ranking.
- III.** Student will demonstrate effective communication, lifelong learning ability, integrity, teamwork, leadership qualities, concern to environment and commitment to safety, health, legal and cultural issues in the fields they choose to pursue.

### **Program Outcomes (POs):**

Engineering Graduate will be able to:

**PO1: Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problem.

**PO2: Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science, and engineering sciences.

**PO3: Design/Development Solution:** Design solution for complex engineering problems and design system component or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, social and environmental conditions.

**PO4: Conduct Investigation of Complex Problem:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusion.

**PO5: Method, Tool Usage:** Create, select and apply appropriately technique, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding the limitation.

**PO6: The Engineer and Society:** Apply reasoning informed by the contextual knowledge to access societal health, safety, legal and cultural and consequent responsibility relevant to the professional engineering practice.

**PO7: Environment and Sustainability:** Understand the impact of the professional engineering solution in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

**PO8: Ethics:** Apply ethical principle and commitment to professional ethics and responsibilities and norms of the engineering practices.

**PO9: Individual and Team Work:** Function effectively as an individual, and as the member or leader in diverse team and multidisciplinary setting.

**PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, and being able to comprehend and write effective reports and design documentation and effective presentation and give and receive clear instructions.

**PO11: Project management and Finance:** Demonstrate knowledge & understanding of the engineering and management principles and apply these to one's work, as the member and the leader in a team to manage projects and in multidisciplinary environment.

**PO12: Lifelong Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in broadest context of technological change.

**T.Y. B. Tech.**  
**Instrumentation and Control Engineering**

**List of Abbreviations**

| <b>Abbreviation</b> | <b>Title</b>                                               | <b>No of Courses</b> | <b>Credits</b> | <b>% of Credits</b> |
|---------------------|------------------------------------------------------------|----------------------|----------------|---------------------|
| BS                  | Basic Science Course                                       |                      |                |                     |
| ESC                 | Engineering Science Course                                 |                      |                |                     |
| PCC                 | Programme Core Course (PCC)                                | 07                   | 24             |                     |
| PEC                 | Programme Elective Course (PEC)                            | 02                   | 06             |                     |
| OE/SE               | Open/School Elective (OE/SE) other than particular program | 01                   | 03             |                     |
| MDM                 | Multidisciplinary Minor (MDM)                              | 02                   | 08             |                     |
| VSEC                | Vocational and Skill Enhancement Course (VSEC)             |                      |                |                     |
| HSMC                | Humanities Social Science and Management                   |                      |                |                     |
| IKS                 | Indian Knowledge System (IKS)                              |                      |                |                     |
| VEC                 | Value Education Course (VEC)                               |                      |                |                     |
| RM                  | Research Methodology (RM)                                  |                      |                |                     |
| --                  | Internship                                                 | 1                    | 1              |                     |
| --                  | Project                                                    | 2                    | 4              |                     |
| CEA                 | Community Engagement Activity (CEA)/Field Project          |                      |                |                     |
| CCA                 | Co-curricular & Extracurricular Activities (CCA)           |                      |                |                     |
| <b>Total</b>        |                                                            | <b>15</b>            | <b>46</b>      | <b>100</b>          |

**T.Y. B. Tech.**  
**Instrumentation and Control Engineering**

**Semester -V**

| Sr. No       | Course Type | Course Code    | Course Name                | L         | T         | P         | S         | Cr        | Evaluation Scheme |    |     |            |     |
|--------------|-------------|----------------|----------------------------|-----------|-----------|-----------|-----------|-----------|-------------------|----|-----|------------|-----|
|              |             |                |                            |           |           |           |           |           | Theory            |    |     | Laboratory |     |
|              |             |                |                            |           |           |           |           |           | MS E              | TA | ESE | ISE        | ESE |
| 1            | PCC-08      | IE-25001       | Digital Signal Processing  | 2         | 1         | 2         | 1         | 4         | 30                | 20 | 50  | 50         | 50  |
| 2            | PCC-09      | IE-25002       | Control System Design      | 3         | 0         | 2         | 1         | 4         | 30                | 20 | 50  | 50         | 50  |
| 3            | PCC-10      | IE-25003       | Process Loop Components    | 2         | 0         | 2         | 1         | 3         | 30                | 20 | 50  | 50         | 50  |
| 4            | PEC-01      |                | Program Elective Course-I  | 3         | 0         | 0         | 1         | 3         | 30                | 20 | 50  | --         | --  |
| 5            | OE-03       | OEC-25009      | Sensors and Actuators      | 2         | 0         | 0         | 1         | 2         | 30                | 20 | 50  | --         | --  |
| 6            | OJT-01      | IE-25004       | Internship                 | --        | --        | --        | --        | 1         |                   |    |     | 50         | 50  |
| 7            | VSEC-01     | IE-25005       | Project Stage I            | --        | --        | 4         | --        | 2         |                   |    |     | 50         | 50  |
| 8            | MDM-01      | IE (MDM)-25002 | Multidisciplinary Minor-II | 3         | 1         | 0         | 1         | 4         | 30                | 20 | 50  | 50         | 50  |
| <b>Total</b> |             |                |                            | <b>15</b> | <b>02</b> | <b>10</b> | <b>06</b> | <b>23</b> |                   |    |     |            |     |
|              |             |                |                            |           |           |           |           |           |                   |    |     |            |     |

**Program Elective Course-I**

1. Process Plant Operations
2. Statistics and Data Analytics
3. Anatomy and Physiology
4. Robotics and Automation

**Multidisciplinary Minor-II**

Information Technology Act 2000

### Semester -VI

| Sr. No       | Course Type | Course Code | Course Name                  | L         | T         | P         | S         | C r       | Evaluation Scheme |    |     |            |     |
|--------------|-------------|-------------|------------------------------|-----------|-----------|-----------|-----------|-----------|-------------------|----|-----|------------|-----|
|              |             |             |                              |           |           |           |           |           | Theory            |    |     | Laboratory |     |
|              |             |             |                              |           |           |           |           |           | MS E              | TA | ESE | ISE        | ESE |
| 1            | PCC-08      | IE-25006    | Power Electronics and Drives | 2         | 0         | 2         | 1         | 3         | 30                | 20 | 50  | 50         | 50  |
| 2            | PCC-09      | IE-25007    | Analytical Instrumentation   | 2         | 0         | 2         | 1         | 3         | 30                | 20 | 50  | 50         | 50  |
| 3            | PCC-10      | IE-25008    | Industrial Automation        | 3         | 0         | 2         | 1         | 4         | 30                | 20 | 50  | 50         | 50  |
| 4            | PCC-11      | IE-25009    | Instrument System Design     | 2         | 0         | 2         | 1         | 3         | 30                | 20 | 50  | 50         | 50  |
| 5            | PEC-01      |             | Program Elective Course-2    | 3         | 0         | 0         | 1         | 3         | 30                | 20 | 50  | 50         |     |
| 6            | VSEC-01     | IE-25010    | Project Stage I              | --        | --        | 4         | --        | 2         |                   |    |     | 50         | 50  |
| 7            | MDM-02      |             | Multidisciplinary Minor-III  | 3         | 0         | 2         | 1         | 4         | 30                | 20 | 50  | 50         | 50  |
| <b>Total</b> |             |             |                              | <b>15</b> | <b>00</b> | <b>14</b> | <b>06</b> | <b>22</b> |                   |    |     |            |     |

- Exit option to qualify for Certification:
  - B. Voc.: Internship of 8 Weeks (2 Credits)

#### **Program Elective Course-II**

1. Nonlinear Control
2. Introduction to AIML
3. Medical Devices
4. Internet of Things

#### **Multidisciplinary Minor-III**

IPR in Cyber World

**Semester - V**

| Digital Signal Processing                                                                                                                                                                                                                                                      |          |                           |           |            |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------|-----------|------------|------------|
| <b>Course Code</b>                                                                                                                                                                                                                                                             | IE-25001 | <b>Examination Scheme</b> |           |            |            |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                         | 3-1-2-1  | <b>Theory</b>             | TA:<br>20 | MSE:<br>30 | ESE:<br>50 |
| <b>Credits</b>                                                                                                                                                                                                                                                                 | 4        | <b>Laboratory</b>         | -         | -          | -          |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                    |          |                           |           |            |            |
| 1. Apply DFT and FFT methods for various signals and determine their frequency response.<br>2. Design and analysis of FIR filters using different techniques.<br>3. Design and analysis of IIR filters using different techniques.<br>4. Design and analyze multi-rate system. |          |                           |           |            |            |

|                                                                                                                                                                                                                                                                                                                                                                |                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)</b>                                                                                                                                                                                                                                                                                       | <b>[07Hrs]</b> |
| Introduction, Discrete Fourier transform of discrete time signal, properties of DFT, relation between DFT & Z transform, analysis of LTI discrete time systems using DFT, Fast Fourier transform, decimation in time algorithm, decimation in frequency algorithm, computation of inverse DFT using FFT.                                                       |                |
| <b>FIR Filters</b>                                                                                                                                                                                                                                                                                                                                             | <b>[06Hrs]</b> |
| Finite Impulse Response Filters - Introduction to finite impulse response filters, linear phase filters, symmetric & anti-symmetric filters, Design of FIR filter: windowing method, analysis of different types of windows, frequency sampling method, optimal equiripple, FIR differentiators.                                                               |                |
| <b>IIR Filters</b>                                                                                                                                                                                                                                                                                                                                             | <b>[07Hrs]</b> |
| Infinite Impulse Response - Filter Introduction to Infinite Impulse Response filter, Butterworth, Chebyshev approximation. Design of IIR filters: Impulse invariant method, bilinear transformation, approximation derivative method, IIR filters design using least square method, Frequency transformations - low pass to high pass, band pass, band reject. |                |
| <b>Multi-Rate Filters and Sampling</b>                                                                                                                                                                                                                                                                                                                         | <b>[08Hrs]</b> |
| Changing the sampling rate, Down sampling, Up sampling, Fractional rate changes, Poly phase Decomposition, Narrowband filter banks, Delay Systems, Integer sampling rate converters, Rational sampling rate converters, Multi rate filter realization structure.                                                                                               |                |
|                                                                                                                                                                                                                                                                                                                                                                |                |

|                         |                                                                                                    |
|-------------------------|----------------------------------------------------------------------------------------------------|
| <b>Textbooks:</b>       |                                                                                                    |
| [1]                     | A. Nagoor Kani, "Digital Signal processing", Tata McGraw Hill 2nd edition 2012.                    |
| [2]                     | P. Ramesh Babu, Digital Signal Processing", Scitech, 7th edition, 2011.                            |
| [3]                     | Proakis, Manolakis, "DSP Principles, algorithms and applications-", Pearson, Fourth edition, 2009. |
| <b>Reference Books:</b> |                                                                                                    |
| [1]                     | A Antoniou, "DSP filter analysis and Design", McGraw Hill, 1979                                    |
| [2]                     | Oppenheim and Schaffer, "Discrete time signal processing", Pearson Publication, 2nd edition, 2007  |

| Digital Signal Processing Laboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                          |                           |        |        |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------|--------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | IE-25001                                                                                                                                                 | <b>Examination Scheme</b> |        |        |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0-0-2-0                                                                                                                                                  | <b>Theory</b>             | TA: -  | MSE: - | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                          | <b>Laboratory</b>         | CIE:50 | ESE-50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                          |                           |        |        |        |
| <ol style="list-style-type: none"> <li>1. Understand the basic operations of signal processing &amp; plot basic discrete/digital signals using MATLAB.</li> <li>2. Analyze and examine the sampling theorem</li> <li>3. Demonstrate interpolation and decimation operations.</li> <li>4. Evaluate magnitude and phase spectrum of a discrete time signal using DFT to determine the spectral components of the signal.</li> <li>5. Develop and design IIR and FIR band pass, band stop, low pass and high pass filters.</li> <li>6. Apply DFT and FFT methods for various signals and determine their frequency response.</li> <li>7. Design and analysis of FIR filters using different techniques.</li> <li>8. Design and analysis of IIR filters using different techniques.</li> <li>9. Design and analyze multi-rate system.</li> </ol> |                                                                                                                                                          |                           |        |        |        |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                          |                           |        |        |        |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Computation of impulse response of LTI system for given transfer function find the impulse response and print the output sequence using DSP LCDK6748 kit |                           |        |        |        |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Determine the DFT and IDFT of a given input signal.                                                                                                      |                           |        |        |        |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Implementation of FFT algorithm.                                                                                                                         |                           |        |        |        |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Design a FIR filter with windowing technique.                                                                                                            |                           |        |        |        |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Design the IIR Butterworth filter.                                                                                                                       |                           |        |        |        |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Design the IIR Chebyshev filter.                                                                                                                         |                           |        |        |        |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Program for illustration of up sampling                                                                                                                  |                           |        |        |        |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Program for illustration of effect of up sampling in frequency domain                                                                                    |                           |        |        |        |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Program for illustration of the effect of anti-imaging filter                                                                                            |                           |        |        |        |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Program for illustration of down sampling                                                                                                                |                           |        |        |        |
| 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Program for illustration of effect of down sampling in frequency domain.                                                                                 |                           |        |        |        |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Program for illustration of the effect of anti-aliasing filter                                                                                           |                           |        |        |        |

| <b>Control System Design</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                           |        |         |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------|--------|---------|-----------------|
| <b>Course code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <i>IE-25002</i> | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3-0-2-1         | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 4               | <b>Laboratory</b>         | -      | -       | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                    |                 |                           |        |         |                 |
| 1. An ability to design controller in time domain and frequency domain<br>2. An ability to design controller in state space<br>3. Ability to design observer<br>4. Ability to design compensators in time and frequency domain                                                                                                                                                                                                                                                 |                 |                           |        |         |                 |
| <b>Compensator design with root locus</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                           |        |         | <b>[07 Hrs]</b> |
| Compensator design with root locus: transient response via gain adjustment, improving time domain specifications (steady state error, transient response) by cascade compensation, feedback compensation.                                                                                                                                                                                                                                                                      |                 |                           |        |         |                 |
| <b>Controller design</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                           |        |         | <b>[07 Hrs]</b> |
| Design of Proportional (P), Integral (I), Derivative (D), PI, PD, PID controllers, lead, lag, lead-lag controller by root locus method.                                                                                                                                                                                                                                                                                                                                        |                 |                           |        |         |                 |
| <b>Design of controller in frequency domain</b>                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                           |        |         | <b>[08 Hrs]</b> |
| Design of controller with bode plot, improvement of steady state and transient response with lead, lag, lead lag compensator design.                                                                                                                                                                                                                                                                                                                                           |                 |                           |        |         |                 |
| <b>State Space</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                           |        |         | <b>[09 Hrs]</b> |
| General state space representation, converting state space to transfer function and vice versa controller design introduction, design with state feedback controller and Ackerman's formula, Observer Design: Pole placement, solving pole placement with MATLAB, Controllability, different approaches for controller design, Introduction to observer, full order and reduced order observer, observability, different approaches for observability design, Output feedback. |                 |                           |        |         |                 |
| <b>Optimal control of mechanical systems</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                           |        |         | <b>[09 Hrs]</b> |
| Quadratic optimal regulator systems, Continuous time linear quadratic regulator (LQR), Steady state and sub optimal control, minimum time and constrained input design, LQR with output feed back, tracking problems, Kalman filter, Linear quadratic Gaussian (LQG) design, LQG/LTR design.                                                                                                                                                                                   |                 |                           |        |         |                 |

| <b>Reference Books:</b> |                                                                                                                                               |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| [1]                     | Franklin G.F., Powell J.D., Emami-Naeini A., Feedback Control of Dynamic Systems, Pearson, Upper Saddle River, New Jersey, 5th edition, 2006. |
| [2]                     | Ogata K., Modern Control Engineering, Prentice-Hall of India Pvt Ltd., New Delhi, 3rd edition, 2000.                                          |
| [3]                     | Kuo B.C., Automatic Control Systems, Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition, 1991.                                           |
| [4]                     | Brogan W. L., Modern Control theory, Prentice Hall International, New Jersey.                                                                 |

| <b>Control System Design Laboratory</b>                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                 |                           |        |        |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------|--------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                | <i>IE-25002</i>                                                                                                                                 | <b>Examination Scheme</b> |        |        |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                            | 0-0-2-0                                                                                                                                         | <b>Theory</b>             | TA: -  | MSE: - | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                 | <b>Laboratory</b>         | CIE:50 | ESE-50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                       |                                                                                                                                                 |                           |        |        |        |
| <ol style="list-style-type: none"> <li>1. Able to design controllers and observer for general systems to validate performance on real time system</li> <li>2. Able to design PI, PD, PID controllers and evaluate the performance</li> <li>3. Able to design and validate the effect of uncertainty and disturbances on controller and observer design</li> </ol> |                                                                                                                                                 |                           |        |        |        |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                 |                           |        |        |        |
| 1                                                                                                                                                                                                                                                                                                                                                                 | Simulation of a lag, lead and lead-lag compensator for a given linear system and comparison of compensated and uncompensated systems responses. |                           |        |        |        |
| 2                                                                                                                                                                                                                                                                                                                                                                 | Design of PI, PD and PID controller using time and frequency domain Specifications                                                              |                           |        |        |        |
| 3                                                                                                                                                                                                                                                                                                                                                                 | Software program for determining a state-space model for a given transfer function and vice versa.                                              |                           |        |        |        |
| 4                                                                                                                                                                                                                                                                                                                                                                 | Software program for determining the state transition matrix.                                                                                   |                           |        |        |        |
| 5                                                                                                                                                                                                                                                                                                                                                                 | Software program for checking the observability and controllability of a given system.                                                          |                           |        |        |        |
| 6                                                                                                                                                                                                                                                                                                                                                                 | Simulation of state feedback control design using software.                                                                                     |                           |        |        |        |
| 7                                                                                                                                                                                                                                                                                                                                                                 | Simulation of a full-order observer-based state feedback control system.                                                                        |                           |        |        |        |
| 8                                                                                                                                                                                                                                                                                                                                                                 | Design of a linear quadratic regulator for a given system using simulation                                                                      |                           |        |        |        |
| 9                                                                                                                                                                                                                                                                                                                                                                 | Study effect of uncertainty and disturbance on system performance                                                                               |                           |        |        |        |
| 10                                                                                                                                                                                                                                                                                                                                                                | Validation of PID controller design on DC Motor set up (position and speed control).                                                            |                           |        |        |        |
| 11                                                                                                                                                                                                                                                                                                                                                                | Validation of lag-lead compensator design on second order electric network.                                                                     |                           |        |        |        |

| Process Loop Components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |                           |        |         |                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------|--------|---------|-----------------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | IE-25003 | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2-0-2-1  | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 3        | <b>Laboratory</b>         |        | -       | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |                           |        |         |                 |
| <ol style="list-style-type: none"> <li>1. Examine the operation of the transmitter, final control elements, pneumatic and hydraulic components generally used in plants</li> <li>2. Design the required features of transmitter, final control elements, pneumatic and hydraulic components for specific application</li> <li>3. Review the performance of the transmitter, final control elements, pneumatic and hydraulic components.</li> <li>4. Simulate and solve the problems associated with the functioning of transmitter, pneumatic system, and hydraulic system in instrumentation and control engineering.</li> </ol>                                                                                                                                                                                                                                                                                                                                           |          |                           |        |         |                 |
| <b>Auxiliary Components</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |                           |        |         | <b>[08 Hrs]</b> |
| Auxiliary Components: Manual switches, Mechanical switches, Relays: Electromechanical, Relay Logic, Solid state relays, relay packages Contactors: Comparison between relay & contactor, contactor size and ratings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |                           |        |         |                 |
| <b>Final Control Elements</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |                           |        |         | <b>[08 Hrs]</b> |
| Operation of control valve, Classification of control valves based on: Valve body. Construction, Advantages, Disadvantages & applications, Types of actuators: Spring Diaphragm, Piston cylinder(power cylinder), Pneumatic, Hydraulic, Electro-hydraulic, Electric, and smart actuators, fail-safe operation. Control valve terminology: Range ability, valve capacity, Flashing, Cavitations, dead band, response time, Control valve characteristics: Inherent & installed, Valve sizing. Positioners: Application/Need, Types, Effect on performance of control valves, Volume boosters, Pressure Boosters etc.                                                                                                                                                                                                                                                                                                                                                         |          |                           |        |         |                 |
| <b>Introduction to Transmitters</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |                           |        |         | <b>[08 Hrs]</b> |
| Function of a transmitter, types, signal conditioning, characterization and calibration, Installation, Commissioning and trouble shooting of a transmitter, auxiliary components like manifolds etc. SMART transmitter: Comparison with conventional transmitter, Block schematic. Function of a converter, types (I/P and P/I), signal conditioning, characterization and calibration, Installation, commissioning, and trouble shooting of a converter, auxiliary components like lock down relay etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |                           |        |         |                 |
| <b>Pneumatic Supply and its components &amp; Hydraulic supply</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |                           |        |         | <b>[08 Hrs]</b> |
| <p><b>Pneumatic Supply and its components:</b> Filter Regulator Lubricator (FRL), Single acting &amp; Double acting cylinder, Special cylinders, Operation of Direction Control valves, Types of pilot signal, operation of speed regulators, pressure control valve, Special valves like quick exhaust, pressure, time delay valve, Standard Symbols for pneumatic components Pneumatic Circuits: Sequence diagram (step-displacement) for implementing pneumatic circuits, Different Pneumatic Circuits using standard symbols for components: direct acting control, indirect acting control, pressure sequencing, block transfer etc.</p> <p><b>Hydraulic supply:</b> reservoir, Types of filters, Function of accumulators, Hydraulic Actuators, Operation of Direction Control Valve, Standard symbols for hydraulic components, Hydraulic Circuits: Meter in, Meter out, Reciprocating, speed control, Sequencing of cylinders, Direction control, applications.</p> |          |                           |        |         |                 |

| <b>Text Books:</b>      |                                                                                                              |
|-------------------------|--------------------------------------------------------------------------------------------------------------|
| [1]                     | Norman A. Anderson , “Instrumentation for Process Measurement and Control”, CRC Press, Third Edition, 1980   |
| [2]                     | Industrial Electronics ,Petruzella (Manual),Tata McGraw Hill.                                                |
| [3]                     | Pneumatic Instrumentation by Majumdar, TMH                                                                   |
| <b>Reference Books:</b> |                                                                                                              |
| [1]                     | William Andrews, “Applied Instrumentation in Process Industries”, Gulf, Second Edition, 1979                 |
| [2]                     | B. G. Liptak, “Process Control, Instrument Engineering Hand book”, Chilton Book Company, Third Edition, 1995 |
| [3]                     | Control Valve Handbook, Fisher Controls International, Inc. third Edition, 2001                              |

| Process Loop Components Laboratory                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                   |                           |        |        |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------|--------|--------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                       | IE-25003                                                                                          | <b>Examination Scheme</b> |        |        |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                   | 0-0-2-0                                                                                           | <b>Theory</b>             | TA: -  | MSE: - | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                   | <b>Laboratory</b>         | CIE:50 | ESE-50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                              |                                                                                                   |                           |        |        |        |
| <ol style="list-style-type: none"> <li>1. Design signal conditioning circuit for transmitter design.</li> <li>2. Understand and operate final control element</li> <li>3. Understand standard symbols used for components in industry</li> <li>4. Select and use pneumatic components to build pneumatic circuit for given application.</li> <li>5. Formulate and solve a problem based on learned components</li> </ol> |                                                                                                   |                           |        |        |        |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                   |                           |        |        |        |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                        | Design of signal conditioning for a K-type thermocouple/ RTD                                      |                           |        |        |        |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                        | Configuration of D.P Transmitter and its application for flow measurement                         |                           |        |        |        |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                        | Development of mathematical model of control valve                                                |                           |        |        |        |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                        | Calibration and fault finding of I/P converter                                                    |                           |        |        |        |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                        | Size a control valve for given applications                                                       |                           |        |        |        |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                        | Study of control valve & plot the characteristics of control valve                                |                           |        |        |        |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                        | Design High/Low selector for given application                                                    |                           |        |        |        |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                        | Design alarm Annunciator for given application                                                    |                           |        |        |        |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                        | Learn operation of pneumatic components like DCVs, time delay valve, pressure sequence valve, etc |                           |        |        |        |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                       | Design and develop pneumatic circuit to operate single acting and double acting cylinder          |                           |        |        |        |
| 11                                                                                                                                                                                                                                                                                                                                                                                                                       | Design and Develop pneumatic circuit to press glued components                                    |                           |        |        |        |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                       | Design and Develop pneumatic circuit for plastic components embossing                             |                           |        |        |        |
| 13                                                                                                                                                                                                                                                                                                                                                                                                                       | Design and Develop pneumatic circuit to transfer block from a magazine                            |                           |        |        |        |
| 14                                                                                                                                                                                                                                                                                                                                                                                                                       | Design and develop pneumatic circuit for sequencing of cylinders                                  |                           |        |        |        |
| 15                                                                                                                                                                                                                                                                                                                                                                                                                       | Design and develop electro-pneumatic circuit                                                      |                           |        |        |        |
| 16                                                                                                                                                                                                                                                                                                                                                                                                                       | Designing intrinsic safety circuits (Zener barrier)                                               |                           |        |        |        |
| 17                                                                                                                                                                                                                                                                                                                                                                                                                       | Field Visit                                                                                       |                           |        |        |        |

| Process Plant Operations                                                                                                                                                                                                                                                                                                                                                                                                                       |         |                           |        |         |                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------------------|--------|---------|-----------------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |         | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                         | 3-0-0-1 | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3       | <b>Laboratory</b>         | CIE:50 | ESE-50  | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                    |         |                           |        |         |                 |
| 1 Knowledge of unit operations and effect of different parameters on these operations.<br>2 Acquaintance with different equipment used for unit operations.<br>3 Apply basic measures to control and monitor unit operations.<br>4 Propose/Design the unit operation sequence and equipment required in different industries.                                                                                                                  |         |                           |        |         |                 |
| <b>Introduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |         |                           |        |         | <b>[04 Hrs]</b> |
| Unit operations and unit processes. Basic concepts of corrosion and protection from corrosion. Selection materials, metals & alloys used in construction of field instruments for different applications.                                                                                                                                                                                                                                      |         |                           |        |         |                 |
| <b>Transportation of Fluid &amp; Equipment</b>                                                                                                                                                                                                                                                                                                                                                                                                 |         |                           |        |         | <b>[08 Hrs]</b> |
| Definition and classification, Rheological behavior of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Basic equations of fluid flow – Continuity equation, and Bernoulli equation; Types of flow – laminar and turbulent; Reynolds experiment. Basic understanding about piping, valves. Specifications and working of pumps, compressors, fans, blowers. Selection of equipment and its material for different applications. |         |                           |        |         |                 |
| <b>Heat transfer and Equipment</b>                                                                                                                                                                                                                                                                                                                                                                                                             |         |                           |        |         | <b>[08 Hrs]</b> |
| Modes of heat transfer; Conduction–steady state heat conduction, Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor. Basic principles, working and selection criteria and control for double pipe, shell & tube heat exchangers, boilers, condensers, evaporators, cooling towers.                        |         |                           |        |         |                 |
| <b>Mass transfer and Equipment</b>                                                                                                                                                                                                                                                                                                                                                                                                             |         |                           |        |         | <b>[08 Hrs]</b> |
| Mass, heat, and momentum transfer analogies Material balance with or without chemical reactions mass transfer coefficients. Principles, working design considerations and control for equipment used for unit operations like distillation, extraction, drying, humidification, dehumidification.                                                                                                                                              |         |                           |        |         |                 |
| <b>Mechanical particulates and Screening and Equipment</b>                                                                                                                                                                                                                                                                                                                                                                                     |         |                           |        |         | <b>[08 Hrs]</b> |
| Introduction of Particulate Sizes and Shapes, Principle, working design considerations and control for equipment used for unit operations like Screening, Size Reduction, Filtration Cross Flow Filtration and Membrane Separations, Gravity Sedimentation Processes, Centrifugal Separations, Floatation.                                                                                                                                     |         |                           |        |         |                 |
| <b>Unit operations in different industries</b>                                                                                                                                                                                                                                                                                                                                                                                                 |         |                           |        |         | <b>[04 Hrs]</b> |
| Identification and justification of unit operations used in different industries like food, pharma, paper, sugar, cement, fertilizer, Petrochemical industry with help of process flow diagram.                                                                                                                                                                                                                                                |         |                           |        |         |                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                |         |                           |        |         |                 |

|                         |                                                                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Textbooks:</b>       |                                                                                                                                           |
| [1]                     | Unit operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot, McGraw-Hill Education (India) Edition 2014. |
| [2]                     | Transport Process Principles and Unit Operations by Christie Geankoplis, Prentice Hall of India.                                          |
| <b>Reference Books:</b> |                                                                                                                                           |
| [1]                     | Instrument Engineers Handbook: Process Control by Bela G Liptak, Pearson Education, Third ed., 1985.                                      |

| Statistics and Data Analytics                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                 |  |                    |         |         |                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--|--------------------|---------|---------|----------------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                 |  | Examination Scheme |         |         |                |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                                                               | 3-0-0-1                                                                                                         |  | Theory             | TA: 20  | MSE: 30 | ESE: 50        |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                       | 3                                                                                                               |  | Laboratory         | CIE: 50 | ESE: 50 | --             |
| <b>Course Outcomes:</b> Students will be able to:                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                 |  |                    |         |         |                |
| <ul style="list-style-type: none"><li>• Understanding the data representation and analysis</li><li>• Understanding descriptive Statistics</li><li>• Understanding Predictive Modelling for decision making</li><li>• Understanding Inferential Statistics and Scientific Hypothesis testing methodology</li><li>• Understanding Regression and Correlation analysis for Causal Inferencing and Association Analysis</li></ul> |                                                                                                                 |  |                    |         |         |                |
| <b>Introduction to data Analytics :</b>                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                 |  |                    |         |         | <b>[5 Hrs]</b> |
| Types of Data, Scales of Measurement, Aligning to Goals of Analysis                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                 |  |                    |         |         |                |
| <b>Unit II Data Visualization and interpretation:</b>                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                 |  |                    |         |         | <b>[6 Hrs]</b> |
| Visualisation as a Discovery tool, The Visualisation methodology, Choosing an effective Visual, Pre-attentive Attributes. Scatter Plot, Bar Chart, Histogram, Line Charts, Pareto Charts, Showing Changes over a period of time.                                                                                                                                                                                              |                                                                                                                 |  |                    |         |         |                |
| <b>Descriptive Statistics:</b>                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                 |  |                    |         |         | <b>[4 Hrs]</b> |
| Measures of Central Tendency, Measures of Variability, Outlier Detection                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                 |  |                    |         |         |                |
| <b>Predictive modelling :</b>                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                 |  |                    |         |         | <b>[6 Hrs]</b> |
| Predictive model building, Parametric distributions, Using Normal, Poisson and Binomial Distributions for predictive analytics                                                                                                                                                                                                                                                                                                |                                                                                                                 |  |                    |         |         |                |
| <b>Inferential Statistics I:</b>                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                 |  |                    |         |         | <b>[8 Hrs]</b> |
| Hypothesis Testing, Null and Alternate Hypothesis, Type I and Type II Errors, Statistical Tests, Tests for Difference in Means, Z test, one sample t test, two sample t test, paired comparison t test. Concept of ANOVA. Alpha and Beta Errors, Statistical Significance, p values                                                                                                                                           |                                                                                                                 |  |                    |         |         |                |
| <b>Inferential Statistics II:</b>                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                 |  |                    |         |         | <b>[6 Hrs]</b> |
| Simple Linear Regression & Correlation, Mann-Whitney test, Wilcoxon signed-rank test, Chi Squared (proportion) Test of Independence.                                                                                                                                                                                                                                                                                          |                                                                                                                 |  |                    |         |         |                |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                 |  |                    |         |         |                |
| [1]                                                                                                                                                                                                                                                                                                                                                                                                                           | Probability and Statistics for Engineering and Sciences,8 <sup>th</sup> Edition, Jay L Devore, Cengage Learning |  |                    |         |         |                |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                 |  |                    |         |         |                |
| [1]                                                                                                                                                                                                                                                                                                                                                                                                                           | Miller and Freund’s Probability and statistics for Engineers, 8 <sup>th</sup> Edition, PHI (Reference)          |  |                    |         |         |                |

| <b>Anatomy and Physiology</b>                                                                                                                                                                                                                                                                                                           |         |                           |        |         |                 |
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| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                      |         | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                  | 3-0-0-1 | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                          | 3       | <b>Laboratory</b>         | -      | -       | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                             |         |                           |        |         |                 |
| 1. Describe human body structure.<br>2. Understand working of different physiological systems of human body.<br>3. Explain the functioning of the human body system.<br>4. Understand biological control and feedback mechanism.<br>5. Apply knowledge of human anatomy and physiology to solve different biomedical research problems. |         |                           |        |         |                 |
| <b>Introduction to cell, Blood</b>                                                                                                                                                                                                                                                                                                      |         |                           |        |         | <b>[03 Hrs]</b> |
| Introduction to cell, Blood: Characteristics of blood, physiology of blood clotting, biochemical cycle.                                                                                                                                                                                                                                 |         |                           |        |         |                 |
| <b>Heart (Circulatory System) and Respiratory System</b>                                                                                                                                                                                                                                                                                |         |                           |        |         | <b>[08 Hrs]</b> |
| Heart (Circulatory System)-Anatomy of heart and blood vessels, origin and conduction of heartbeat, cardiac cycle, electrocardiogram, blood pressure, control of cardiac cycle. Respiratory System- Anatomy of respiratory system, physiology of respiration in the alveolar and tissue capillaries, control of respiration.             |         |                           |        |         |                 |
| <b>Digestive system, Kidney and Urinary system</b>                                                                                                                                                                                                                                                                                      |         |                           |        |         | <b>[04 Hrs]</b> |
| Digestive system: Anatomy of digestive system, nerve and blood supply, physiology of digestion. Kidney and Urinary system - Anatomy of urinary system and kidney, physiology of water and electrolyte balance, acid-base regulation.                                                                                                    |         |                           |        |         |                 |
| <b>Muscle Tissues</b>                                                                                                                                                                                                                                                                                                                   |         |                           |        |         | <b>[08 Hrs]</b> |
| Muscle Tissues - Anatomy, types of muscles, physiology of muscle contraction, generation of action potential, rhythmicity of cardiac muscle contraction, properties of skeletal and Cardiac muscles.                                                                                                                                    |         |                           |        |         |                 |
| <b>Nervous system, Sensory system, and Endocrine system</b>                                                                                                                                                                                                                                                                             |         |                           |        |         | <b>[09 Hrs]</b> |
| Nervous system - Neuron, anatomy and function of different parts of brain, spinal cord, autonomic nervous system, Sensory system - Visual, auditory, Vestibular Endocrine system- pituitary, thyroid, parathyroid, adrenal, pancreas, biological control and feed-back mechanism, clinical and technological implications               |         |                           |        |         |                 |

| <b>Reference Books:</b> |                                                                                                                       |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------|
| [1]                     | “Ross & Wilson Anatomy and Physiology in Health and Illness”, by Allison Grant, Anne Waugh, and Kathleen J. W. Wilson |
| [2]                     | Anatomy and Physiology for Engineers- A handbook for biomedical engineers- by P. Manimegalal                          |

| Robotics and Automation                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                   |                    |        |          |         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------|--------|----------|---------|
| Course Name                                                                                                                                                                                                                                                                                                                                                                                                             | IE(PE)-25003                                                                                                                      | Examination Scheme |        |          |         |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                                                         | 3-0-0-1                                                                                                                           | Theory             | TA: 20 | MSE: 30  | ESE: 50 |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                 | 3                                                                                                                                 | Laboratory         | -      | -        | -       |
| Course Outcomes: At the end of the course, students will demonstrate the ability to:                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                   |                    |        |          |         |
| 1. Perform kinematic and dynamic analyses with simulation.<br>2. Design control laws for a robot.<br>3. Integrate mechanical and electrical hardware for a real prototype of robotic device.<br>4. Select a robotic system for given application.                                                                                                                                                                       |                                                                                                                                   |                    |        |          |         |
| Introduction to Robotics                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                   |                    |        | [07 Hrs] |         |
| Types and components of a robot, Classification of robots, closed-loop and open loop control systems. Kinematics systems; Basic definitions of Robotics, Descriptions: Positions, Orientations, Frames, Robot Anatomy – Links, Joints and Joint Notation scheme, Degrees of Freedom (DOF), mechanisms and manipulators, Required DOF in a Manipulator.                                                                  |                                                                                                                                   |                    |        |          |         |
| Robot Kinematics and Dynamics                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                   |                    |        | [07 Hrs] |         |
| Kinematic Modeling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics, Dynamic Modeling: Equations of motion: Euler-Lagrange formulation                                                                                                                                                                                                            |                                                                                                                                   |                    |        |          |         |
| Robotic Sensors and Actuators                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                   |                    |        | [08 Hrs] |         |
| Robotic sensor: Contact and Proximity, Position, Velocity, Force, Tactile, Force-Torque sensors. Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators. Vision System: Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics. |                                                                                                                                   |                    |        |          |         |
| Robotics Control                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                   |                    |        | [07 Hrs] |         |
| Robotics control: Second order linear system, Feedback control laws: P, PD, PID, Non-linear trajectory tracking control, joint controller, Control Hardware and Interfacing with sensors, actuators, components, Robotic Programming (ROS and VAL II), Applications of Industrial robot (PUMA, KUKA, FANUC, MTAB).                                                                                                      |                                                                                                                                   |                    |        |          |         |
| Artificial Intelligence in Robotics                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                   |                    |        | [06 Hrs] |         |
| Artificial Intelligence in Robotics: Applications in unmanned systems, defense, medical, process industries, Motion planning – potential fields, projective path planning, Robotics and Automation for Industry 4.0                                                                                                                                                                                                     |                                                                                                                                   |                    |        |          |         |
| Text Books:                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                   |                    |        |          |         |
| [1]                                                                                                                                                                                                                                                                                                                                                                                                                     | Ashitava Ghoshal, Robotics Fundamental Concepts & Analysis, Oxford University Press. (2006).                                      |                    |        |          |         |
| [2]                                                                                                                                                                                                                                                                                                                                                                                                                     | Mittal and Nagrath, Robotics and Control, Tata McGraw-Hill Publishing Company Ltd., New Delhi (2004).                             |                    |        |          |         |
| [3]                                                                                                                                                                                                                                                                                                                                                                                                                     | Nikku, S.B., Introduction to Robotics, Prentice Hall of India Private Limited (2002).                                             |                    |        |          |         |
| [4]                                                                                                                                                                                                                                                                                                                                                                                                                     | Saha, S.K., “Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.                                |                    |        |          |         |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                   |                    |        |          |         |
| [1]                                                                                                                                                                                                                                                                                                                                                                                                                     | Richard D. Klafter, Thomas A Chmielewski and Michael Negin, Robotics Engineering: An integrated approach, Prentice Hall. (1998)   |                    |        |          |         |
| [2]                                                                                                                                                                                                                                                                                                                                                                                                                     | John Craig, Introduction to Robotics, mechanics and control, Pearson Education, New Delhi. (2005)                                 |                    |        |          |         |
| [3]                                                                                                                                                                                                                                                                                                                                                                                                                     | M.P. Groover, Mitchell Weiss, Roger N. Nagel & Nicholas Godfrey, Industrial Robotics. Tata McGraw Hill Education Pvt. Ltd. (2001) |                    |        |          |         |
| [4]                                                                                                                                                                                                                                                                                                                                                                                                                     | Gonzalex, R. C. and Fu, K. S., Robotics Control Sensing, Vision and Intelligence, McGraw Hill (1985).                             |                    |        |          |         |
| [5]                                                                                                                                                                                                                                                                                                                                                                                                                     | Koren,Y., Robotics for Engineers, McGraw Hill (2004).                                                                             |                    |        |          |         |

| IOC Industrial Automation                                                                                                                                                                                                                                                                                                                                                                 |                                                                                |  |                    |         |         |                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--|--------------------|---------|---------|----------------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                               |                                                                                |  | Examination Scheme |         |         |                |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                           | 2-0-0-0                                                                        |  | Theory             | TA: 20  | MSE: 30 | ESE: 50        |
| Credits                                                                                                                                                                                                                                                                                                                                                                                   | 2                                                                              |  | Laboratory         | CIE: 00 | ESE: 00 | --             |
| <b>Course Outcomes:</b> Students will be able to:                                                                                                                                                                                                                                                                                                                                         |                                                                                |  |                    |         |         |                |
| 1. Select field instruments for given requirement<br>2. Design solution for engineering application<br>3. Implement solution to automate the operation<br>4. Evaluate functioning automation solution                                                                                                                                                                                     |                                                                                |  |                    |         |         |                |
| <b>Basics of Automation</b>                                                                                                                                                                                                                                                                                                                                                               |                                                                                |  |                    |         |         | <b>[6 Hrs]</b> |
| Introduction and evolution of Automation, Feedback and feed forward systems, Hierarchical levels of automation, introduction to plant automation.                                                                                                                                                                                                                                         |                                                                                |  |                    |         |         |                |
| <b>Field Instruments</b>                                                                                                                                                                                                                                                                                                                                                                  |                                                                                |  |                    |         |         | <b>[6 Hrs]</b> |
| Standard signals, types of switches, working of transmitters, Types of transmitters, calibration of transmitters, types of valves used in Industries, working principle of pneumatically operated control valve and motorized control valve, Pneumatic direction control valves, pressure regulator, pressure relief valve, hydraulic direction control valves, electropneumatic valve    |                                                                                |  |                    |         |         |                |
| <b>Programmable Logic Controller</b>                                                                                                                                                                                                                                                                                                                                                      |                                                                                |  |                    |         |         | <b>[6 Hrs]</b> |
| Block schematic of PLC, Programming languages, basic instruction for programming, Demonstration of PLC functioning and development of ladder for sequencing of motors, tank level control, temperature control. working and automation of pump house, Motor Control Centre (MCC), elevator, Sequencing of pneumatic cylinders, bottle filling application. Introduction to SCADA and HMI. |                                                                                |  |                    |         |         |                |
| <b>Advances in Automation</b>                                                                                                                                                                                                                                                                                                                                                             |                                                                                |  |                    |         |         | <b>[6 Hrs]</b> |
| Communication protocols, HART, Fieldbus, ControlNet, wireless communication, Distributed Control System, Plant wide automation                                                                                                                                                                                                                                                            |                                                                                |  |                    |         |         |                |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                         |                                                                                |  |                    |         |         |                |
| [1]                                                                                                                                                                                                                                                                                                                                                                                       | Process control Instrumentation Technology by C D Johnson, Pearson Publication |  |                    |         |         |                |
| [2]                                                                                                                                                                                                                                                                                                                                                                                       | Programmable Logic Controllers by Garry Dunning, 3rd Ed, PHI Pub. 2004.        |  |                    |         |         |                |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                   |                                                                                |  |                    |         |         |                |
| [1]                                                                                                                                                                                                                                                                                                                                                                                       | Process Control, Instrument Engineering Handbook by B G Liptak, CRC Press      |  |                    |         |         |                |
| [2]                                                                                                                                                                                                                                                                                                                                                                                       | Process software and Digital Network Handbook by B G Liptak, CRC Press         |  |                    |         |         |                |

| <b>Project Stage I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |                           |        |        |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|--------|--------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <i>IE-25005</i>        | <b>Examination Scheme</b> |        |        |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Practical: 4 hrs./week | <b>Theory</b>             | TA: -  | MSE: - | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2                      | <b>Laboratory</b>         | CIE:50 | ESE-50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                        |                           |        |        |        |
| <ol style="list-style-type: none"> <li>1. Able to apply the knowledge and skills previously gained into practice.</li> <li>2. Take appropriate decisions with respect to various parameters related to production of a system or sub-system.</li> <li>3. Demonstrate the leadership quality along with ability to work in a group.</li> <li>4. Prove the ability to present the findings in a written report or oral presentation.</li> </ol>                                                                                                                                                                                                     |                        |                           |        |        |        |
| <b>Project Development Activity</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                           |        |        |        |
| Students are required to develop various modules required for their final year project, or a mini project e.g. power supply, processor module, interfacing module, display and signal conditioning module. The PCB and enclosure design is part of the activity of this subject. Testing of various modules as per industrial standards and practices is part of the experimental work. System Design Selection of sensors, signal conditioning, standard signals and noise considerations of typical systems. Student has to develop a mini project which will handle and measure a physical parameter such as temperature, pressure, vibration. |                        |                           |        |        |        |
| <b>Group Formation &amp; Scope</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                        |                           |        |        |        |
| The project Stage-I shall be carried out in-house i.e. in the department's laboratories/centres by a group 2 – 3 students. In any case the group shall not consist of more than three students. The project Stage-I shall consist of design and implementation of any suitable electronic system, sub system or circuit based on knowledge and skills previously gained.                                                                                                                                                                                                                                                                          |                        |                           |        |        |        |
| <b>Planning &amp; Documentation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                           |        |        |        |
| The project Stage-I outline (a brief or condensed information giving a general view of project topic) on the selected topic should be submitted to the course coordinator for approval within one weeks from the commencement of the term. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation.                                                                                                                                                                                                                                                              |                        |                           |        |        |        |
| <b>Deliverables</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                           |        |        |        |
| A project stage-I report as per the specified format (available on in the department and institutes website), developed system in the form of hardware and/or software. In addition, student shall maintain a record of attendance and continuous progress (log book in appropriate format available on institute/department's web site) duly signed by course coordinator and present as project stage-I deliverable along with report.                                                                                                                                                                                                          |                        |                           |        |        |        |
| <b>Evaluation System: Internal Continuous Assessment (ICA)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                        |                           |        |        |        |
| <ul style="list-style-type: none"> <li>• The ICA shall be evaluated by course coordinator.</li> <li>• Course coordinator shall judge the students on the principle of continuous evaluation and contribution of individual student in the group.</li> <li>• It shall be evaluated on the basis of deliverables of project stage-I and depth of understanding.</li> <li>• Course coordinator shall maintain the record of continuous evaluation in appropriate format available on institute/department's web site.</li> </ul>                                                                                                                     |                        |                           |        |        |        |
| <b>Evaluation System: End Semester Examination (ESE)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                           |        |        |        |
| The End Semester Examination for this course shall be based on demonstration of the system or sub system developed by the group of students, deliverables of project stage-I and depth of understanding (oral examination). It shall be evaluated by two examiners out of which one examiner shall be out of institute.                                                                                                                                                                                                                                                                                                                           |                        |                           |        |        |        |

| Internship                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |                           |         |         |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---------|---------|--|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | IE-25004               | <b>Examination Scheme</b> |         |         |  |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Practical: 6 hrs./week | <b>Theory</b>             | TA: -   | MSE: -  |  |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1                      | <b>Laboratory</b>         | CIE: 50 | ESE: 50 |  |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                           |         |         |  |
| <ol style="list-style-type: none"> <li>1. Demonstrate an understanding of industrial practices, challenges, and work ethics.</li> <li>2. Apply theoretical and technical knowledge to practical, real-world industry problems.</li> <li>3. Work collaboratively in professional environments and communicate effectively.</li> <li>4. Identify gaps in their knowledge and acquire new skills relevant to industry requirements.</li> <li>5. Prepare detailed documentation and deliver technical presentations based on internship work.</li> </ol> |                        |                           |         |         |  |
| <b>Internship Guidelines &amp; Expectations</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |                           |         |         |  |
| <b>Overview &amp; Expectations</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |                           |         |         |  |
| During the internship, students are expected to engage in structured industrial training under the supervision of qualified professionals. The training should provide exposure to real-time work environments and organizational practices relevant to the student's field of study.                                                                                                                                                                                                                                                                |                        |                           |         |         |  |
| <b>Activities &amp; Workplace Norms</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |                           |         |         |  |
| Activities may include observing and participating in ongoing projects, assisting in technical or managerial tasks, familiarizing themselves with industry-standard tools and technologies, and understanding workflow processes. Students are required to maintain a professional attitude, adhere to workplace norms and safety regulations, and demonstrate effective communication and teamwork skills.                                                                                                                                          |                        |                           |         |         |  |
| <b>Deliverables &amp; Evaluation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |                           |         |         |  |
| Throughout the internship period, students must document their experiences and learning outcomes in a logbook, culminating in a detailed internship report and a presentation to be evaluated by a faculty panel.                                                                                                                                                                                                                                                                                                                                    |                        |                           |         |         |  |

**Semester - VI**

| Power Electronics and Drives                                                                                                                                                                                                                                                                                                                                                                                             |          |                           |        |         |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------|--------|---------|-----------------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                       | IE-25006 | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                   | 2-0-2-1  | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                           | 3        | <b>Laboratory</b>         | -      | -       | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                              |          |                           |        |         |                 |
| 1. Understand, select and analyze operations of different power devices for different power electronics applications [PO1]<br>2. Classify, select and design different converters for various practical applications [PO3]<br>3. Understand the importance of power quality aspect [PO2]<br>4. Analyze different machine drives [PO3]<br>5. Understand and apply different control strategies for power converters [PO1] |          |                           |        |         |                 |
| <b>Rectifiers and Converters</b>                                                                                                                                                                                                                                                                                                                                                                                         |          |                           |        |         | <b>[08 Hrs]</b> |
| Diode rectifiers - Single Phase, three phase and polyphase; Controlled rectifiers – Single phase, three phase, PWM rectifiers and power factor improvement techniques; DC-DC Converters – Choppers, Buck converter, Boost converter, Buck-Boost converter, Cuk converter, Bidirectional converters, Applications of DC-DC Converters                                                                                     |          |                           |        |         |                 |
| <b>Inverter and Cycloconverter</b>                                                                                                                                                                                                                                                                                                                                                                                       |          |                           |        |         | <b>[08 Hrs]</b> |
| Inverters – Introduction, Single phase & Three phase Voltage Source Inverters, Current source inverters, Close loop operation of inverters, multi-stage inverters; AC-AC converters – Single phase AC-AC voltage converter, three phase AC-AC converter, Cycloconverter, Matrix converter                                                                                                                                |          |                           |        |         |                 |
| <b>Machine Drives</b>                                                                                                                                                                                                                                                                                                                                                                                                    |          |                           |        |         | <b>[08 Hrs]</b> |
| DC motor drives, Induction motor drives, synchronous motor drives, Permanent magnet synchronous motor drives, Permanent magnet brushless DC motor drives, Servo drives, stepper motor drives, switched reluctance motor drives, synchronous reluctance motor drives, Sensorless vector and Direct torque-controlled drives                                                                                               |          |                           |        |         |                 |
| <b>Control Methods for Power converters</b>                                                                                                                                                                                                                                                                                                                                                                              |          |                           |        |         | <b>[08 Hrs]</b> |
| Introduction – Linear & non-linear control in power electronics, Power converter control using state space averaged models, sliding mode control of power converters, introduction to Fuzzy logic and AI based control of power converters.                                                                                                                                                                              |          |                           |        |         |                 |

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|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>Text Books:</b>      |                                                                                                                                      |
| [1]                     | Power Electronics – Converters, Applications and Design, Ned Mohan, Undeland, Riobbins, Wiley Student 3rd Edition 2003 Edition, 2015 |
| [2]                     | Electric Motors and Drives – Fundamentals, types and Applications, Austin Huges & Bill Drury, Newnes Publication 4th Edition, 2013   |
| <b>Reference Books:</b> |                                                                                                                                      |
| [1]                     | Power Electronics – Drives, Circuits and Applications, Muhammad H. Rashid, Pearson Publication 4th Edition, 2014                     |
| [2]                     | Fundamentals of Power Electronics, Robert W. Erickson & Dragan Maksimovie, Springer, 2nd Edition, 2001                               |

| <b>Power Electronics and Drives Laboratory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                |                           |        |        |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------|--------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | IE-25006                                                                                                                                                                       | <b>Examination Scheme</b> |        |        |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0-0-2-0                                                                                                                                                                        | <b>Theory</b>             | TA: -  | MSE: - | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                | <b>Laboratory</b>         | CIE:50 | ESE-50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                |                           |        |        |        |
| <ol style="list-style-type: none"> <li>1. Understand, select and analyze operations of different power devices for different power electronics applications [PO1]</li> <li>2. Classify, select and design different converters for various practical applications [PO3]</li> <li>3. Understand the importance of power quality aspect [PO2]</li> <li>4. Analyze different machine drives [PO3]</li> <li>5. Understand and apply different control strategies for power converters [PO1]</li> </ol> |                                                                                                                                                                                |                           |        |        |        |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                |                           |        |        |        |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | To study and analyse the operation, characteristics, and output waveforms of: a Single-Phase Half-Wave Controlled Rectifier, and a Single Phase Full-Wave Controlled Rectifier |                           |        |        |        |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | To study and analyse the operation, characteristics, and output waveforms of: a Three-Phase Half-Wave Controlled Rectifier, and a Single Phase Full-Wave Controlled Rectifier  |                           |        |        |        |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Study and Performance Analysis of DC-DC Boost Converter                                                                                                                        |                           |        |        |        |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Study and Performance Analysis of DC-DC Buck Converter                                                                                                                         |                           |        |        |        |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Size a control valve for given applications                                                                                                                                    |                           |        |        |        |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Study and Performance Analysis of DC-DC Boost-Buck Converter                                                                                                                   |                           |        |        |        |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Study and Performance Analysis of Bidirectional converter                                                                                                                      |                           |        |        |        |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Study and Analysis of DC Motor Drives                                                                                                                                          |                           |        |        |        |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Study and Analysis of Permanent Magnet Brushless DC (PMBLDC) Motor Drives                                                                                                      |                           |        |        |        |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Study of Power Converter Control Using State-Space Averaged Method                                                                                                             |                           |        |        |        |
| 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Study of Speed Control of DC Motor Using Voltage Controlled Method                                                                                                             |                           |        |        |        |

| <b>Analytical Instrumentation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                           |        |         |                 |
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| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | IE-25007 | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2-0-2-1  | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3        | <b>Laboratory</b>         | -      | -       | -               |
| <b>Course Outcomes: At the end of the course, a student will be able to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |                           |        |         |                 |
| 1. Select the required instruments for spectroscopic analysis. [PEO1][PO-3]<br>2. Understand the effects of different constituent in a process outcome and analysis the performance of various on-line or off-line instruments. [PEO3][PO-10]<br>3. Apply the knowledge of chromatography to separate the constituents from a complex mixture. [PEO1][PO-11]<br>4. Distinguish gas analyzer based on different principles [PEO2][PO-5]<br>5. Interpret/ summarize chemical sensors and associated research in analytical instrumentation [PEO3][PO-12]. |          |                           |        |         |                 |
| <b>Introduction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |                           |        |         | <b>[07 Hrs]</b> |
| Introduction to Chemical instrumental analysis, advantages over classical methods, classification: Spectral, electro analytical and separative methods, Interaction of radiation with matter, Source (continuous and LASER), detector and optics design, Benchtop type colorimeter, online colorimeter for process applications, turbidity meter, turbidity analyzers and its applications                                                                                                                                                              |          |                           |        |         |                 |
| <b>UV-Visible and FTIR Spectrophotometers</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |                           |        |         | <b>[07 Hrs]</b> |
| UV-Visible spectrophotometers and its types with its optical system design and its applications, UV and Visible analyzers with its applications in process industries, FTIR spectrophotometers and its applications                                                                                                                                                                                                                                                                                                                                     |          |                           |        |         |                 |
| <b>Chromatographic Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |                           |        |         | <b>[07 Hrs]</b> |
| Classification of Chromatographic methods, Gas chromatography, Process Gas Chromatograph, High Performance Liquid Chromatography (HPLC), applications in industries such as process, food and pharmaceuticals, ICP- mass spectrometer                                                                                                                                                                                                                                                                                                                   |          |                           |        |         |                 |
| <b>Gas Analyzers and Chemical Sensors</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |                           |        |         | <b>[07 Hrs]</b> |
| Types of gas analyzers based on measurement of quantities such as infrared absorption, chemiluminescence, Introduction to chemical sensors based system design, semiconductor gas sensors for trace gas analysis and monitoring                                                                                                                                                                                                                                                                                                                         |          |                           |        |         |                 |
| <b>Self Study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |                           |        |         |                 |
| <b>Emission spectroscopy:</b> Flame Photometry: Principle, constructional details, flue gases, atomizer, burner, optical system, recording system.<br><br><b>Atomic absorption spectrophotometers:</b> Theoretical concepts, instrumentation: hollow cathode lamps, burners and flames, plasma excitation sources, optical and electronic system.<br><br><b>Gas analyzers</b> based on paramagnetic, zirconia, and thermal conductivity, Voltametry and conductometry based liquid analyzers.                                                           |          |                           |        |         |                 |

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| <b>Text Books:</b>      |                                                                                                                              |
| [1]                     | Instrumental Methods of Analysis, Willard, Merritt, Dean, Settle, CBS Publishers & Distributors, New Delhi, Seventh edition. |
| [2]                     | Handbook of Analytical Instruments, R. S. Khandpur, Tata McGraw–Hill Publications, 3rd edition                               |
| [3]                     | Principles of Instrumental Analysis, Skoog, Holler, Nieman, Thomson books-cole publications, 5th edition.                    |
| <b>Reference Books:</b> |                                                                                                                              |
| [1]                     | Instrumental Methods of Chemical Analysis, Galen W. Ewing, McGraw-Hill Book Company, Fifth edition.                          |
| [2]                     | Introduction to Instrumental Analysis, Robert D. Braun, McGraw-Hill Book Company.                                            |

| <b>Analytical Instrumentation Laboratory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                           |                           |        |         |         |
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| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | IE-25007                                                                                                                                  | <b>Examination Scheme</b> |        |         |         |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0-0-2-0                                                                                                                                   | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50 |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                           | <b>Laboratory</b>         | CIE:50 | ESE-50  | -       |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                           |                           |        |         |         |
| 1. Select the required instruments for spectroscopic analysis. [PEO1][PO-3]<br>2. Understand the effects of different constituent in a process outcome and analysis the performance of various on-line or off-line instruments. [PEO3][PO-10]<br>3. Apply the knowledge of chromatography to separate the constituents from a complex mixture. [PEO1][PO-11]<br>4. Distinguish gas analyzer based on different principles [PEO2][PO-5]<br>5. Interpret/ summarize chemical sensors and associated research in analytical instrumentation [PEO3][PO-12]. |                                                                                                                                           |                           |        |         |         |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                           |                           |        |         |         |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Design a handheld visible spectrophotometer for qualitative analysis of sample                                                            |                           |        |         |         |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Visible spectrophotometer for qualitative and qualitative measurement of sample                                                           |                           |        |         |         |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | UV-Visible spectrophotometer for qualitative and qualitative measurement of sample and compare the results with Visible spectrophotometer |                           |        |         |         |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | To analyze a given liquid sample using combinations of light source and detectors and evaluate its performance                            |                           |        |         |         |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Turbidity sensor system for liquid sample analysis                                                                                        |                           |        |         |         |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Design a gas sensor system and evaluate its performance.                                                                                  |                           |        |         |         |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Design Thermal conductivity detector using open-source software                                                                           |                           |        |         |         |
| 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Analyze GC data and comment on its performance parameters                                                                                 |                           |        |         |         |
| 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Analyze HPLC data and comment on its performance parameters                                                                               |                           |        |         |         |
| 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Design chemical sensor system                                                                                                             |                           |        |         |         |

| <b>Industrial Automation</b>                                                                                                                                                                                                                                                                                                        |          |                           |        |         |                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------|--------|---------|-----------------|
| <b>Course Name</b>                                                                                                                                                                                                                                                                                                                  | IE-25008 | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                              | 3-0-2-1  | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                      | 3        | <b>Laboratory</b>         | -      | -       | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                         |          |                           |        |         |                 |
| 1. Examine hierarchy of Industrial Automation<br>2. Solve the problem in control network<br>3. Demonstrate functions of Programmable Logic Controller<br>4. Develop control logic for engineering system                                                                                                                            |          |                           |        |         |                 |
| <b>Introduction to Automation</b>                                                                                                                                                                                                                                                                                                   |          |                           |        |         | <b>[08 Hrs]</b> |
| Evolution of instrumentation and Control, types of industries, Benefits of automation, Computer based-Plant Automation, Evolution of Hierarchical system structure, Continuous versus Discrete Process Control                                                                                                                      |          |                           |        |         |                 |
| <b>Instrumentation Standard Protocols</b>                                                                                                                                                                                                                                                                                           |          |                           |        |         | <b>[08 Hrs]</b> |
| An introduction to network, Introduction to open system interconnection (OSI) model, overall fieldbus trends, Instrumentation Network Design, Fieldbus advantages and disadvantages, HART Network, Foundation Fieldbus Network, Modbus TCP/IP, Ethernet and TCP/IP based system                                                     |          |                           |        |         |                 |
| <b>Programmable Logic Controller</b>                                                                                                                                                                                                                                                                                                |          |                           |        |         | <b>[08 Hrs]</b> |
| Introduction to Programmable Logic Controller, Architecture of PLC, Types of Input & Output modules (AI, DI, AO, DO), wiring diagram, ladder diagram using standard symbols, PLC specifications, PLC manufacturers, PLC ladder diagram, basic instructions, Timers, counters instruction with timing diagram, advanced instructions |          |                           |        |         |                 |
| <b>SCADA and Its Applications</b>                                                                                                                                                                                                                                                                                                   |          |                           |        |         | <b>[08 Hrs]</b> |
| Introduction to SCADA and Its Applications, Automation of pump house, Motor Control Centre (MCC), elevator, drilling station, bottle filling station                                                                                                                                                                                |          |                           |        |         |                 |
| <b>Distributed Control System</b>                                                                                                                                                                                                                                                                                                   |          |                           |        |         | <b>[08 Hrs]</b> |
| Introduction to Distributed Control System, Functional level, data base organization, Operator interface, Introduction to Object Linking and Embedding (OLE) for Process Control, application software, and Knowledge-based software                                                                                                |          |                           |        |         |                 |
| <b>Hazardous Area Classification and Safety</b>                                                                                                                                                                                                                                                                                     |          |                           |        |         | <b>[08 Hrs]</b> |
| Hazardous area classification as per IEC standard, Protection Methods, Explosion Proof Housing, Encapsulation, Sealing, & Immersion, Purging systems, intrinsic safety, Concept of safety cycle                                                                                                                                     |          |                           |        |         |                 |

#### **Text Books:**

- |     |                                                                                                                       |
|-----|-----------------------------------------------------------------------------------------------------------------------|
| [1] | Gary Dunning , “Introduction to Programmable Logic Controller”, Cengage Learning India Pvt. Ltd., Third Edition, 2006 |
| [2] | John W. Webb, “Programmable Logic Controllers”, Prentice Hall, Fourth Edition, 1999                                   |

#### **Reference Books:**

- |     |                                                                                                               |
|-----|---------------------------------------------------------------------------------------------------------------|
| [1] | B. G. Liptak , “Process Control, Instrument Engineering Hand book”, Chilton Book Company, Third Edition, 1995 |
| [2] | B. G. Liptak, “Process Software and Digital Networks”, CRC Press. Third Edition 2000                          |

| <b>Industrial Automation Laboratory</b>                                                                                                                                                                                                                                    |                                                                                                        |                           |        |        |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------|--------|--------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                         | IE-25008                                                                                               | <b>Examination Scheme</b> |        |        |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                     | 0-0-2-0                                                                                                | <b>Theory</b>             | TA: -  | MSE: - | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                             |                                                                                                        | <b>Laboratory</b>         | CIE:50 | ESE-50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                |                                                                                                        |                           |        |        |        |
| 1. Understanding of architectures of Programmable Logic Controller<br>2. Understanding communication protocol and networking with controller<br>3. Develop programming skills for Programmable Logic Controller<br>4. Solve engineering problem using programming language |                                                                                                        |                           |        |        |        |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                 |                                                                                                        |                           |        |        |        |
| 1                                                                                                                                                                                                                                                                          | Implementation of logical function using PLC programming                                               |                           |        |        |        |
| 2                                                                                                                                                                                                                                                                          | Implementation of Timer and counter for a given applications using PLC programming                     |                           |        |        |        |
| 3                                                                                                                                                                                                                                                                          | Implementation of PLC programming for applications like elevator, bottle filling, motor control center |                           |        |        |        |
| 4                                                                                                                                                                                                                                                                          | Interfacing PLC to Pneumatic circuits                                                                  |                           |        |        |        |
| 5                                                                                                                                                                                                                                                                          | Interfacing PLC to Variable Frequency Drive                                                            |                           |        |        |        |
| 6                                                                                                                                                                                                                                                                          | Study of HART protocol                                                                                 |                           |        |        |        |
| 7                                                                                                                                                                                                                                                                          | Communicate field devices using fieldbus protocol to delta V controller                                |                           |        |        |        |
| 8                                                                                                                                                                                                                                                                          | Study of Delta-V distributed control System architecture                                               |                           |        |        |        |
| 9                                                                                                                                                                                                                                                                          | Configuration and commissioning of Digital I/O's                                                       |                           |        |        |        |
| 10                                                                                                                                                                                                                                                                         | Configuration and commissioning of Analog I/O's for a typical system                                   |                           |        |        |        |
| 11                                                                                                                                                                                                                                                                         | Configuration and commissioning of control block for a typical system                                  |                           |        |        |        |
| 12                                                                                                                                                                                                                                                                         | Configure PID block for given control loop                                                             |                           |        |        |        |
| 13                                                                                                                                                                                                                                                                         | Development of GUI for a typical plant.                                                                |                           |        |        |        |
| 14                                                                                                                                                                                                                                                                         | Development of an alarm, and historian system for a typical process.                                   |                           |        |        |        |
| 15                                                                                                                                                                                                                                                                         | Study Modbus protocol for controller to controller communication                                       |                           |        |        |        |

| Instrument System Design                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |                           |        |         |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------|--------|---------|-----------------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | IE-25009 | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2-0-2-1  | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | -        | <b>Laboratory</b>         | -      | -       | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |                           |        |         |                 |
| <ol style="list-style-type: none"> <li>1. Need analysis of system requirement</li> <li>2. Identify circuit noise and system components</li> <li>3. Understand and design various noise reduction techniques.</li> <li>4. Select and design appropriate shielding and enclosures</li> <li>5. Estimate and analyze the reliability of instruments and system</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |                           |        |         |                 |
| <b>Basic Concept of Instrumentation Design</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |                           |        |         | <b>[08 Hrs]</b> |
| Basic Concept of Instrumentation Design, Needs Analysis with respect to systems deployed in Automobile, Medical, Industrial, Agriculture, Test and Measurement, Home Appliances, Military Functional requirements & Specifications, Impact on the design due to adverse Electrical, Thermal and Mechanical Operational Environments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |                           |        |         |                 |
| <b>Noise Sources and Shielding</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |                           |        |         | <b>[08 Hrs]</b> |
| Noise sources, electrical, magnetic, RF, static, ground loops, shielding, near and far field, shielding effectiveness, absorption and reflection loss, shielding with magnetic material, contact protection, glow and arc discharges, loads with high inrush current, Inductive and resistive load contact protection networks for inductive loads, intrinsic noise sources.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                           |        |         |                 |
| <b>ESD and Grounding Techniques</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |                           |        |         | <b>[07 Hrs]</b> |
| ESD, inductive charging human body model, ESD protection in equipment, software in ESD protection, Sensitive devices, input filters, clamping suppressors. Electronic design guideline Noise in electronic circuits. Capacitive and inductive coupling and effect of shield, shielding to prevent magnetic radiation, co-axial and twisted pair cable, grounding, safety ground, signal ground, single and multi-point ground, Hybrid ground, grounding of cables shields, Ground loops and low frequency analysis of common mode signals, guard shields                                                                                                                                                                                                                                                                                                                                                           |          |                           |        |         |                 |
| <b>Enclosure Design and Reliability</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |                           |        |         | <b>[08Hrs]</b>  |
| Enclosure Design Guidelines: NEMA, DIN, BSI, ANSI standards Index protection (IP), Cable design guidelines: Printed circuit board design guideline, layout scheme, grid systems, PCB size, Design rules for digital circuits, and Design rules for analog circuits, single and multilayer PCB, CE / Underwrites Laboratories (UL) Compliance, Reliability, bathtub curve, Reliability for series parallel system, MTTF, MTBF, availability, Redundancy and standby systems                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |                           |        |         |                 |
| <b>Course Activities &amp; Project Phases</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |                           |        |         |                 |
| <b>Activities:</b> <ul style="list-style-type: none"> <li>• Quiz / Review sessions (04) uniformly spaced out during the delivery of lecture sessions</li> <li>• Homework / Project presentation</li> <li>• Design of Instrument or Control system for a process.</li> </ul> <b>Project Phases (Submit detailed design progressively):</b> <ol style="list-style-type: none"> <li>1. Needs analysis Requirement specifications &amp; Functional specifications. At the end of unit 1</li> <li>2. Detailed design with components at the end of unit 2,3</li> <li>3. Enclosure design, PCB design with wiring and layout or Control panel design instruments layout wiring in the form of P and I diagram at the end of unit 3,4</li> <li>4. Adherence to appropriate standards with specific clauses cited at the end of unit 4</li> <li>5. Reliability analysis and closure report at the end of unit 4</li> </ol> |          |                           |        |         |                 |

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|-------------------------|--------------------------------------------------------------------------------------------------------|
| <b>Text Books:</b>      |                                                                                                        |
| [1]                     | Henry OTT, “Noise reduction Techniques in Electronics Circuit”, Wiley International, Second ed., 2009. |
| <b>Reference Books:</b> |                                                                                                        |
| [1]                     | Balguruswamy, “Reliability Engineering”, TATA McGraw-hill Publication, Third ed., 2005                 |
| [2]                     | Walter C. Bosshart, “Printed Circuit Board”, Tata McGraw-Hill publication, Third ed.,2009              |

| Instrument System Design Laboratory                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                         |                           |        |        |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------|--------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                    | IE-25009                                                                                                                                                                                                                | <b>Examination Scheme</b> |        |        |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                | 0-0-2-0                                                                                                                                                                                                                 | <b>Theory</b>             | TA: -  | MSE: - | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                         | <b>Laboratory</b>         | CIE:50 | ESE-50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                         |                           |        |        |        |
| <ol style="list-style-type: none"> <li>1. Need analysis of system requirement</li> <li>2. Identify circuit noise and system components</li> <li>3. Understand and design various noise reduction techniques.</li> <li>4. Select and design appropriate shielding and enclosures</li> <li>5. Estimate and analyze the reliability of instruments and system</li> </ol> |                                                                                                                                                                                                                         |                           |        |        |        |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                         |                           |        |        |        |
| 1                                                                                                                                                                                                                                                                                                                                                                     | Design a simple instrumentation system for measuring temperature using a thermocouple. Implement a feedback control system using basic sensors and simulate its performance                                             |                           |        |        |        |
| 2                                                                                                                                                                                                                                                                                                                                                                     | Design a signal conditioning system for noise reduction in measured data. Build a system that filters raw sensor data using low-pass, high-pass, or band-pass filters. Visualize the signal before and after filtering. |                           |        |        |        |
| 3                                                                                                                                                                                                                                                                                                                                                                     | Model an ESD event using a high-voltage pulse generator and observe the transient response of a sensitive circuit (e.g., a semiconductor diode) to the discharge                                                        |                           |        |        |        |
| 4                                                                                                                                                                                                                                                                                                                                                                     | Develop a Simulink model of the human body model for ESD (with resistance and capacitance) and simulate how static discharge from the human body can affect an electronic circuit                                       |                           |        |        |        |
| 5                                                                                                                                                                                                                                                                                                                                                                     | Model a system that acquires an ECG signal, applies filters, and outputs the processed signal. Include noise and interference in the signal and demonstrate filtering techniques                                        |                           |        |        |        |
| 6                                                                                                                                                                                                                                                                                                                                                                     | Model an industrial motor, including mechanical vibrations. Use sensors to measure vibration levels and implement a vibration control system to minimize harmful oscillations.                                          |                           |        |        |        |
| 7                                                                                                                                                                                                                                                                                                                                                                     | Model a system with an amplifier or sensor and introduce electrical noise sources. Simulate how noise affects the output signal, and analyze the signal-to-noise ratio (SNR)                                            |                           |        |        |        |
| 8                                                                                                                                                                                                                                                                                                                                                                     | Model an electrical system (e.g., sensor or power circuit) in an environment with magnetic interference. Use electromagnetic modeling to simulate how magnetic noise affects system performance                         |                           |        |        |        |
| 9                                                                                                                                                                                                                                                                                                                                                                     | Build a simulation of an electrical system that includes a protection network (e.g., circuit breakers, fuses) to protect against contact faults like short circuits or overloads.                                       |                           |        |        |        |
| 10                                                                                                                                                                                                                                                                                                                                                                    | Model a system where an arc discharge occurs (e.g., when electrical contacts open under high current conditions) and analyze its effects on system performance, including thermal effects                               |                           |        |        |        |
| 11                                                                                                                                                                                                                                                                                                                                                                    | Create a simulation of an inductive load with high inrush current and analyze the transient response. Evaluate the effect of inrush current on power supply and circuit protection devices.                             |                           |        |        |        |

| Introduction to Artificial Intelligence and Machine Learning                                                                                                                                                                                                                                                                                                                                |                                                                                                    |  |                    |         |         |                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--|--------------------|---------|---------|----------------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                    |  | Examination Scheme |         |         |                |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                             | 2-1-0-1                                                                                            |  | Theory             | TA: 20  | MSE: 30 | ESE: 50        |
| Credits                                                                                                                                                                                                                                                                                                                                                                                     | 3                                                                                                  |  | Laboratory         | CIE: 50 | ESE: 50 | --             |
| <b>Course Outcomes:</b> Students will be able to:                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |  |                    |         |         |                |
| 1. Understanding the Artificial Intelligence (AI) and Machine Learning (ML) fundamentals<br>2. Supervised, unsupervised, and semi supervised machine learning algorithms<br>3. Study of data preprocessing and transformation techniques Understanding the various models related to process control applications<br>4. Development of data-based controls for Process Control Applications |                                                                                                    |  |                    |         |         |                |
| <b>Conceptual Introduction:</b>                                                                                                                                                                                                                                                                                                                                                             |                                                                                                    |  |                    |         |         | <b>[4 Hrs]</b> |
| Artificial Intelligence (AI) Fundamentals, defining AI techniques                                                                                                                                                                                                                                                                                                                           |                                                                                                    |  |                    |         |         |                |
| <b>Machine Learning Methods and Algorithms:</b>                                                                                                                                                                                                                                                                                                                                             |                                                                                                    |  |                    |         |         | <b>[10Hrs]</b> |
| Introduction to Machine Learning, classification of Machine Learning algorithms, regression and classification, Linear regression (Simple and Multiple), Logistic regression, Decision tree (Regression and classification), SVM, K means Clustering, Hierarchical Clustering, KNN Classifier.                                                                                              |                                                                                                    |  |                    |         |         |                |
| <b>Process of building ML Models:</b>                                                                                                                                                                                                                                                                                                                                                       |                                                                                                    |  |                    |         |         | <b>[8 Hrs]</b> |
| Supervised, unsupervised and semi-supervised learning, Algorithms. Concepts, instances and attributes, training and testing data, Libraries for ML.                                                                                                                                                                                                                                         |                                                                                                    |  |                    |         |         |                |
| <b>Data Preparation and Model Training:</b>                                                                                                                                                                                                                                                                                                                                                 |                                                                                                    |  |                    |         |         | <b>[6 Hrs]</b> |
| Gradient descent algorithm, cost function, Activation functions, data preprocessing and transformation techniques                                                                                                                                                                                                                                                                           |                                                                                                    |  |                    |         |         |                |
| <b>Reinforcement Learning:</b>                                                                                                                                                                                                                                                                                                                                                              |                                                                                                    |  |                    |         |         | <b>[6 Hrs]</b> |
| Fundamentals of Reinforcement Learning (agent, environment, rewards, policy), Markov Decision Process and value functions, Dynamic programming basics (policy/value iteration concepts), Model-free methods: Monte Carlo and Temporal Difference learning.                                                                                                                                  |                                                                                                    |  |                    |         |         |                |
| <b>Applying Machine Learning in Industry:</b>                                                                                                                                                                                                                                                                                                                                               |                                                                                                    |  |                    |         |         | <b>[8 Hrs]</b> |
| Data based Controls and ML based controls for Process Control Applications.                                                                                                                                                                                                                                                                                                                 |                                                                                                    |  |                    |         |         |                |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |  |                    |         |         |                |
| [1]                                                                                                                                                                                                                                                                                                                                                                                         | Tom Mitchell, "Machine Learning", McGraw-Hill, 1997                                                |  |                    |         |         |                |
| [2]                                                                                                                                                                                                                                                                                                                                                                                         | Ethem Alpaydin, "Introduction to Machine Learning", PHI, 2005.                                     |  |                    |         |         |                |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                    |  |                    |         |         |                |
| [1]                                                                                                                                                                                                                                                                                                                                                                                         | Bishop, C., "Pattern Recognition and Machine Learning:," Berlin: Springer-Verlag, 2006             |  |                    |         |         |                |
| [2]                                                                                                                                                                                                                                                                                                                                                                                         | K.P. Soman, R. Longonathan and V. Vijay, "Machine Learning with SVM and Other Kernel Methods", PHI |  |                    |         |         |                |
| [3]                                                                                                                                                                                                                                                                                                                                                                                         | Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer 2006.                  |  |                    |         |         |                |

| <b>Medical Devices</b>                                                                                                                                                                                                                                                                                                                                                                                                     |              |                           |        |         |                 |
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| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                         | IE(PE)-25006 | <b>Examination Scheme</b> |        |         |                 |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                     | 3-0-0-1      | <b>Theory</b>             | TA: 20 | MSE: 30 | ESE: 50         |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                             | 3            | <b>Laboratory</b>         | -      | -       | -               |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                |              |                           |        |         |                 |
| 1. Select/identify appropriate electrode, sensor and transducer for a physiological measurement.<br>2. Design different biological signal amplifiers and analysis of bio-signals.<br>3. Identify various blocks of biomedical equipment/ instruments.<br>4. Define terms used in respiratory, pathology and radiology measurements.<br>5. Apply electrical safety aspects and standards in medical instruments/ equipment. |              |                           |        |         |                 |
| <b>Cardiovascular and Neural Devices</b>                                                                                                                                                                                                                                                                                                                                                                                   |              |                           |        |         | <b>[08 Hrs]</b> |
| Electrocardiograph (ECG), Electroencephalograph (EEG), Phonocardiograph, Blood pressure measurement, plethysmography                                                                                                                                                                                                                                                                                                       |              |                           |        |         |                 |
| <b>Therapeutic Devices</b>                                                                                                                                                                                                                                                                                                                                                                                                 |              |                           |        |         | <b>[08 Hrs]</b> |
| Short wave diathermy, microwave diathermy, Ultrasonic Therapy unit, transcutaneous electrical nerve stimulators (TENS), radiotherapy                                                                                                                                                                                                                                                                                       |              |                           |        |         |                 |
| <b>Life-saving and Clinical Laboratory Instruments</b>                                                                                                                                                                                                                                                                                                                                                                     |              |                           |        |         | <b>[08 Hrs]</b> |
| <b>Life-saving devices:</b> Ventilators, Pacemakers and defibrillators, Heart-lung machines. <b>Clinical Laboratory Instruments:</b> Electron Microscope, Blood Cell Counters, Electrophoresis, Pulse oximetry, Hb and Glucose measurement, Autoanalyzer                                                                                                                                                                   |              |                           |        |         |                 |
| <b>Electrical Safety and Related Instruments</b>                                                                                                                                                                                                                                                                                                                                                                           |              |                           |        |         | <b>[08 Hrs]</b> |
| Significance of electrical danger, Physiological effects of electrical current, ground shock hazards, methods of accident prevention, Safety standards, leakage current tester, Electrical safety analyzer, Isolation techniques                                                                                                                                                                                           |              |                           |        |         |                 |
| <b>Instrumentation for Medical Imaging</b>                                                                                                                                                                                                                                                                                                                                                                                 |              |                           |        |         | <b>[08 Hrs]</b> |
| X-ray, Computed Tomography (CT), Ultrasound, Nuclear Medical Imaging, Magnetic resonance imaging (MRI), Thermal imaging                                                                                                                                                                                                                                                                                                    |              |                           |        |         |                 |

| <b>Text Books:</b> |                                                                                                                      |
|--------------------|----------------------------------------------------------------------------------------------------------------------|
| [1]                | Carr and Brown; "Introduction to Biomedical Equipment Technology"                                                    |
| [2]                | John G. Webster; "Medical Instrumentation Application and Design" John Wiley & Sons Pvt. Ltd.                        |
| [3]                | M. Arumugam; "Biomedical Instrumentation" Anuradha Publishers (1992)                                                 |
| [4]                | Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer; "Biomedical Instrumentation and Measurements" Pearson Education |
| [5]                | R. S. Khandpur; "Handbook of Biomedical Instrumentation" TMH                                                         |
| [6]                | Richard Aston; "Principles of Biomedical Instrumentation and Measurement" "Maxwell Macmillan International Editions  |
| [7]                | Jacobsons and Webster; "Medicine and Clinical Engineering" PHI                                                       |

| <b>Project Stage-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |                           |         |         |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---------|---------|--------|
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                              | IE-25010               | <b>Examination Scheme</b> |         |         |        |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                          | Practical: 4 hrs./week | <b>Theory</b>             | TA: -   | MSE: -  | ESE: - |
| <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  | -                      | <b>Laboratory</b>         | CIE: 50 | ESE: 50 | -      |
| <b>Course Outcomes: At the end of the course, students will demonstrate the ability to:</b>                                                                                                                                                                                                                                                                                                                                                     |                        |                           |         |         |        |
| <ol style="list-style-type: none"> <li>1. Able to apply the knowledge and skills previously gained into practice.</li> <li>2. Take appropriate decision with respect to various parameters related to production of a system or sub-system.</li> <li>3. Demonstrate the leadership quality along with ability to work in a group.</li> <li>4. 4. Prove the ability to present the findings in a written report or oral presentation.</li> </ol> |                        |                           |         |         |        |

| <b>Project Development &amp; Scope</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Technical Development</b>                | Students are required to develop various modules required for their hardware and software project e.g. power supply, processor module, interfacing module, display and signal conditioning module. The PCB and enclosure design is part of the activity of this subject. Testing of various modules as per industrial standards and practices is part of the experimental work. System Design Selection of sensors, signal conditioning, standard signals and noise considerations of typical systems. Student has to develop a project which will handle and measure a physical parameter such as temperature, pressure, vibration. |
| <b>Execution</b>                            | The hardware and software based project shall be carried out in-house i.e. in the department's laboratories/centres by a group 2 – 3 students. In any case the group shall not consist of more than three students. The project shall consist of design and implementation of any suitable electronic system, sub system or circuit based on knowledge and skills previously gained.                                                                                                                                                                                                                                                 |
| <b>Planning &amp; Deliverables</b>          | An outline on the selected topic should be submitted to the course coordinator for approval within one week of commencement. Deliverables include a project report as per specified format, the developed hardware/software system, and a maintained log book of attendance and progress signed by the coordinator.                                                                                                                                                                                                                                                                                                                  |
| <b>Evaluation System</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Internal Continuous Assessment (ICA)</b> | Evaluated by the course coordinator based on the principle of continuous evaluation, individual contribution in the group, project deliverables, and depth of understanding.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>End Semester Examination (ESE)</b>       | Based on the demonstration of the system or sub-system, project deliverables, and an oral examination. Evaluated by two examiners (one internal and one external).                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |