B. Tech. Degree
In
INSTRUMENTATION AND CONTROL ENGINEERING

SYLLABUS FOR
FLEXIBLE CURRICULUM
(For students admitted in 2015-16, 2016-17 & 2017-18)

DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015
TAMIL NADU, INDIA.
INSTITUTE VISION

- To provide valuable resources for industry and society through excellence in technical education and research.

INSTITUTE MISSION

- To offer state-of-the-art undergraduate, postgraduate and doctoral programmes.
- To generate new knowledge by engaging in cutting-edge research.
- To undertake collaborative projects with academia and industries.
- To develop human intellectual capability to its fullest potential.

DEPARTMENT VISION

- To constantly strive to make this department a world class school in Instrumentation and Control Engineering.

DEPARTMENT MISSION

- To provide high quality education which inspire the students to realize their aspiration and potential.
- To enhance knowledge, create passion for learning, foster innovation and nurture talents towards serving the society and the country.
- To encourage faculty members to update their knowledge and carryout advanced research in cutting edge technologies.
- To exhibit excellence in research projects and consultancy services, for the benefit of the global community.
Programme Educational Objectives (PEOs)

The major objectives of the 4-year B.Tech (ICE) programme offered by the department of Instrumentation & Control Engineering are, to prepare students

1. For employment in the core industrial/manufacturing sector
2. For employment in research and development organizations
3. For employment in electronics & IT/ITES industry
4. For graduate studies in engineering and management
5. For entrepreneurship in the long run

Programme Outcomes (POs)

The students, after undergoing the 4-year B.Tech (ICE) programme,

1. Would have developed an ability to apply the knowledge of mathematics, sciences, and engineering fundamentals to the field of instrumentation & control.
2. Would have possessed a comprehensive understanding of a wider range of electronic devices, analog and digital electronic circuits and the state-of-the-art advanced electronic systems invariably found in every measurement and instrumentation system.
3. Would have the right knowledge of and exposure to a variety of sensors, data acquisition systems, actuators, and control methodologies to readily provide innovative solutions to the day-to-day problems in the core industry (e.g. processes, power plants, automotive).
4. Would have gained adequate knowledge in microprocessors and microcontrollers, embedded systems, data structures, algorithms, computer programming and simulation software to be able to offer services in IT and management sectors.
5. Would have learnt necessary skills to develop mathematical models, and deploy appropriate techniques and IT tools to design advanced control systems and associated instrumentation for problems dealt in R & D organizations.

6. Would be thoroughly prepared and confident to take up complex problems in the field of I & C and provide sustainable solutions by (i) surveying the literature and patents, (ii) designing and conducting experiments, (iii) interpreting the data, (iv) drawing relevant conclusions, with due consideration and responsibility towards the immediate social, cultural, environmental and legal issues, and (v) documenting the research carried out.

7. Would be able to evaluate and deliver the solutions by optimally utilizing the available resources, including finances and project time, by adapting appropriate resource management techniques.

8. Would be competent to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

9. Would be proficient in English language (spoken and written) in order to communicate effectively on complex engineering activities on a global scale, make comprehensive reports and presentations, and give and receive clear instructions.

10. Would have committed to be professionally ethical.

11. Would pledge to function efficiently in various capacities as members, leaders, and directors in multi-disciplinary teams to accomplish projects of different magnitudes, and

12. Would have recognized the need for engaging themselves in independent and life-long learning in the broadest context of technological change.
CURRICULUM

The total minimum credits required for completing the B.Tech. programme in Instrumentation and Control Engineering is **176**.

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>COURSE CATEGORY</th>
<th>NO. OF COURSES</th>
<th>NO. OF CREDITS</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>GENERAL INSTITUTE REQUIREMENT (GIR)</td>
<td>24</td>
<td>68</td>
</tr>
<tr>
<td>2.</td>
<td>PROGRAMME CORE (PC)</td>
<td>20</td>
<td>62</td>
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<td>3.</td>
<td>ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)</td>
<td>8</td>
<td>16</td>
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<td>4.</td>
<td>ELECTIVE COURSES (PE+OE+MI)</td>
<td>10</td>
<td>30</td>
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<td><strong>TOTAL</strong></td>
<td><strong>62</strong></td>
<td><strong>176</strong></td>
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</table>

Programme Electives (PE) are offered by the Department of Instrumentation and Control Engineering for students of B.Tech. in Instrumentation and Control Engineering programme. A minimum of nine credits out of the thirty credits allotted for Electives category must be earned from the courses listed in the PE section.

To meet the minimum credit requirement for Electives, the remaining elective courses can be chosen from either PE courses offered by the Department of Instrumentation and Control Engineering, or Open Electives offered by any other Department within National Institute of Technology, Tiruchirappalli. In addition to the above, the courses registered under B.Tech. (Minor) programme of any other Department, will be considered for Electives category.
I. GENERAL INSTITUTE REQUIREMENT (GIR)

1. MATHEMATICS

<table>
<thead>
<tr>
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<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>MAIR11</td>
<td>Mathematics – I</td>
<td>4</td>
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<tr>
<td>2.</td>
<td>MAIR21</td>
<td>Mathematics – II</td>
<td>4</td>
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<tr>
<td>3.</td>
<td>MAIR36</td>
<td>Algebra and Probability Theory</td>
<td>3</td>
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<td>4.</td>
<td>MAIR43</td>
<td>Numerical Methods</td>
<td>3</td>
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2. PHYSICS

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<tbody>
<tr>
<td>1.</td>
<td>PHIR11</td>
<td>Physics- I</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>PHIR13</td>
<td>Physics- II</td>
<td>4</td>
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3. CHEMISTRY

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<tbody>
<tr>
<td>1.</td>
<td>CHIR11</td>
<td>Chemistry- I</td>
<td>3</td>
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<td>CHIR13</td>
<td>Chemistry- II</td>
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4. COMMUNICATION

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<tbody>
<tr>
<td>1.</td>
<td>HSIR11</td>
<td>English for Communication</td>
<td>3</td>
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<td>2.</td>
<td>HSIR12</td>
<td>Professional Communication</td>
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### 5. HUMANITIES

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<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>HSIR13</td>
<td>Industrial Economics and Foreign Trade</td>
<td>3</td>
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### 6. PROFESSIONAL ETHICS

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<tr>
<td>1.</td>
<td>HSIR14</td>
<td>Professional Ethics and Human Values</td>
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### 7. ENERGY AND ENVIRONMENTAL ENGINEERING

<table>
<thead>
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<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>ENIR11</td>
<td>Energy and Environmental Engineering</td>
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### 8. BASIC ENGINEERING

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</thead>
<tbody>
<tr>
<td>1.</td>
<td>CEIR11</td>
<td>Basics of Civil Engineering</td>
<td>2</td>
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<tr>
<td>2.</td>
<td>MEIR11</td>
<td>Basics of Mechanical Engineering</td>
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### 9. ENGINEERING GRAPHICS

<table>
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<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>MEIR12</td>
<td>Engineering Graphics</td>
<td>3</td>
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## 10. ENGINEERING PRACTICE

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<tbody>
<tr>
<td>1.</td>
<td>PRIR11</td>
<td>Engineering Practice</td>
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## 11. INTRODUCTION TO COMPUTER PROGRAMMING

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<thead>
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<th>Course Title</th>
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<tbody>
<tr>
<td>1.</td>
<td>CSIR11</td>
<td>Basics of Programming</td>
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## 12. BRANCH SPECIFIC COURSE

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<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>ICIR15</td>
<td>Introduction to Instrumentation and Control Systems Engineering</td>
<td>2</td>
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## 13. SUMMER INTERNSHIP

<table>
<thead>
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<th>S.No.</th>
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<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>ICIR16</td>
<td>Internship / Industrial Training / Academic Attachment</td>
<td>2</td>
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<td></td>
<td></td>
<td>(2 To 3 Months Duration During Summer Vacation)</td>
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</table>

Each student should undergo industrial training / internship for a minimum period of two months during the summer vacation of third year. Attachment with an academic institution within the country (CFTIs such as IISc / IITs / NITs / IIITs, etc.) or university abroad is also permitted in place of industrial training. The course will be evaluated at the beginning of the fourth year (VII semester) by assessing the report and seminar presentations.
14. PROJECT WORK

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>ICIR17</td>
<td>Project Work</td>
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15. COMPREHENSIVE VIVA

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<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>ICIR18</td>
<td>Comprehensive Viva-Voce Examination</td>
<td>3</td>
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Note: A Student can appear for Comprehensive Viva-Voce Examination only after completing all the Programme Core (PC) courses.

16. INDUSTRIAL LECTURE

<table>
<thead>
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<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>ICIR19</td>
<td>Industrial Lecture</td>
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</table>

A minimum of five lectures of two hours duration by industry experts will be arranged by the Department. The evaluation methodology, will be based on objective type questioning at the end of each lecture.

17. NSS/NCC/NSO

<table>
<thead>
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<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>SWIR11</td>
<td>NSS/NCC/NSO</td>
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## II. PROGRAMME CORE (PC)

### LIST OF ESSENTIAL PROGRAMME CORE COURSES

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-Req</th>
<th>Credits</th>
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<tr>
<td>1.</td>
<td>ICPC10</td>
<td>Engineering Mechanics</td>
<td>---</td>
<td>3</td>
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<tr>
<td>2.</td>
<td>ICPC11</td>
<td>Sensors and Transducers</td>
<td>---</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>ICPC12</td>
<td>Material Science</td>
<td>---</td>
<td>3</td>
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<tr>
<td>4.</td>
<td>ICPC13</td>
<td>Thermodynamics and Fluid Mechanics</td>
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<td>4</td>
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<tr>
<td>5.</td>
<td>ICPC14</td>
<td>Circuit Theory</td>
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<td>4</td>
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<tr>
<td>6.</td>
<td>ICPC15</td>
<td>Digital Electronics</td>
<td>---</td>
<td>3</td>
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<td>7.</td>
<td>ICPC16</td>
<td>Signals and Systems</td>
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<td>8.</td>
<td>ICPC17</td>
<td>Industrial Instrumentation</td>
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<td>9.</td>
<td>ICPC18</td>
<td>Analog Signal Processing</td>
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<td>10.</td>
<td>ICPC19</td>
<td>Electrical and Electronic Measurements</td>
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<tr>
<td>11.</td>
<td>ICPC20</td>
<td>Microprocessors and Microcontrollers</td>
<td>ICPC15</td>
<td>3</td>
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<tr>
<td>12.</td>
<td>ICPC21</td>
<td>Control Systems – I</td>
<td>---</td>
<td>4</td>
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<tr>
<td>13.</td>
<td>ICPC22</td>
<td>Instrumentation Practices in Industries</td>
<td>ICPC17</td>
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<tr>
<td>14.</td>
<td>ICPC23</td>
<td>Principles of Communication Systems</td>
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<td>15.</td>
<td>ICPC24</td>
<td>Control Systems – II</td>
<td>ICPC21</td>
<td>3</td>
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<td>16.</td>
<td>ICPC25</td>
<td>Process Control</td>
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<td>4</td>
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<td>17.</td>
<td>ICPC26</td>
<td>Product Design and Development (Theory)</td>
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<td>18.</td>
<td>ICPC27</td>
<td>Product Design and Development (Practice)</td>
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<td>19.</td>
<td>ICPC28</td>
<td>Analytical Instrumentation</td>
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<td>20.</td>
<td>ICPC29</td>
<td>Logic and Distributed Control Systems</td>
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III. ELECTIVE COURSES

1. PROGRAMME ELECTIVES (PE)

Students pursuing B.Tech. in Instrumentation and Control Engineering should complete at least three courses from the Programme Electives listed below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course Code</th>
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<th>Pre-Req.</th>
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<tbody>
<tr>
<td>1.</td>
<td>ICPE10</td>
<td>Optical Instrumentation</td>
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<td>2.</td>
<td>ICPE11</td>
<td>Medical Instrumentation</td>
<td>-</td>
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<td>3.</td>
<td>ICPE12</td>
<td>Micro Electro Mechanical Systems</td>
<td>ICPC11</td>
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<td>4.</td>
<td>ICPE13</td>
<td>Automotive Instrumentation</td>
<td>ICPC11 ICPC17</td>
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<tr>
<td>5.</td>
<td>ICPE14</td>
<td>Instrumentation and Control for Power Plant</td>
<td>-</td>
<td>3</td>
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<tr>
<td>6.</td>
<td>ICPE15</td>
<td>Instrumentation and Control for Petrochemical Industries</td>
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<tr>
<td>7.</td>
<td>ICPE16</td>
<td>Instrumentation and Control for Paper Industries</td>
<td>-</td>
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<tr>
<td>8.</td>
<td>ICPE17</td>
<td>Instrumentation for Agricultural and Food Processing Industries</td>
<td>-</td>
<td>3</td>
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<tr>
<td>9.</td>
<td>ICPE18</td>
<td>Introduction to Chemical Processes</td>
<td>-</td>
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<tr>
<td>10.</td>
<td>ICPE19</td>
<td>Measurement Data Analysis</td>
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<td>11.</td>
<td>ICPE20</td>
<td>Building Automation</td>
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<td>12.</td>
<td>ICPE21</td>
<td>Digital Control Systems</td>
<td>ICPC24</td>
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<tr>
<td>13.</td>
<td>ICPE22</td>
<td>Neural Networks and Fuzzy Logic</td>
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<td>14.</td>
<td>ICPE23</td>
<td>Non Linear Control</td>
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<td>15</td>
<td>ICPE24</td>
<td>System Identification and Adaptive Control</td>
<td>ICPC24</td>
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<td>16</td>
<td>ICPE25</td>
<td>Fault Detection and Diagnosis</td>
<td>ICPC21</td>
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<td>17</td>
<td>ICPE26</td>
<td>Computational Techniques in Control Engineering</td>
<td>ICPC24</td>
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<td>18</td>
<td>ICPE27</td>
<td>Process Modelling and Optimization</td>
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<td>19</td>
<td>ICPE28</td>
<td>Control System Components</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>20</td>
<td>ICPE29</td>
<td>Network Control Systems</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>21</td>
<td>ICPE30</td>
<td>Digital Signal Processing</td>
<td>ICPC16</td>
<td>3</td>
</tr>
<tr>
<td>22</td>
<td>ICPE31</td>
<td>Power Electronics</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>23</td>
<td>ICPE32</td>
<td>Real-Time Embedded Systems</td>
<td>ICPC20</td>
<td>3</td>
</tr>
<tr>
<td>24</td>
<td>ICPE33</td>
<td>Smart and Wireless Instrumentation</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>25</td>
<td>ICPE34</td>
<td>Digital Image Processing</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>26</td>
<td>ICPE35</td>
<td>Multi Sensor Data Fusion</td>
<td>ICPC24</td>
<td>3</td>
</tr>
<tr>
<td>27</td>
<td>ICPE36</td>
<td>Medical Imaging Systems</td>
<td>ICPE34</td>
<td>3</td>
</tr>
<tr>
<td>28</td>
<td>ICPE37</td>
<td>Industrial Data Communication</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>29</td>
<td>ICPE38</td>
<td>Energy Harvesting Techniques</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>ICPE39</td>
<td>Smart Materials and Systems</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>31</td>
<td>ICPE40</td>
<td>Hydraulics and Pneumatics</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>32</td>
<td>ICPE41</td>
<td>Internet of Things System Design</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>33</td>
<td>ICPE42</td>
<td>Software Design Tools for Sensing and Control</td>
<td>ICPC11</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ICPC21</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>ICPE43</td>
<td>Industrial Electric Drives</td>
<td>ICPE31</td>
<td>3</td>
</tr>
<tr>
<td>35</td>
<td>ICPE44</td>
<td>Piping and Instrumentation Diagrams</td>
<td>ICPE18</td>
<td>3</td>
</tr>
<tr>
<td>36</td>
<td>ICPE45</td>
<td>Robotics</td>
<td>ICPC21</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ICPC24</td>
<td></td>
</tr>
</tbody>
</table>
2. OPEN ELECTIVES (OE)

The courses listed below are offered by the Department of Instrumentation and Control Engineering for students of other Departments.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-Req</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ICOE10</td>
<td>Building Automation</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ICOE11</td>
<td>Project Engineering and Management</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>ICOE12</td>
<td>Medical Instrumentation</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>ICOE13</td>
<td>Micro Electro Mechanical Systems</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>ICOE14</td>
<td>Measurement and Control</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>ICOE15</td>
<td>Industrial Measurements</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>ICOE16</td>
<td>Virtual Instrument Design</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>ICOE17</td>
<td>Neural Networks and Fuzzy Logic</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>ICOE18</td>
<td>Network Control Systems</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>10.</td>
<td>ICOE19</td>
<td>Control Systems</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>ICOE20</td>
<td>Energy Harvesting Techniques</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>ICOE21</td>
<td>Internet of Things</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>ICOE22</td>
<td>Intellectual Property Rights</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>14.</td>
<td>ICOE23</td>
<td>Smart Materials and Systems</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

3. MINOR (MI)

Students registered for B.Tech. (Minor) in Instrumentation and Control Engineering can opt to study any five of the courses listed below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-Req</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ICMI10</td>
<td>Transducer Engineering</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>S.No.</td>
<td>Course Code</td>
<td>Course Title</td>
<td>Pre-Req</td>
<td>Credits</td>
</tr>
<tr>
<td>-------</td>
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<td>---------</td>
</tr>
<tr>
<td>1.</td>
<td>ICLR10</td>
<td>Thermodynamics and Fluid Mechanics Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>ICLR11</td>
<td>Circuits and Digital Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>ICLR12</td>
<td>Sensors and Transducers Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>ICLR13</td>
<td>Analog Signal Processing Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>ICLR14</td>
<td>Instrumentation Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>ICLR15</td>
<td>Microprocessors and Microcontrollers Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>ICLR16</td>
<td>Control Engineering Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>ICLR17</td>
<td>Industrial Automation and Process Control Laboratory</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

Total: 16

Note: students can register for 2 laboratory courses during one session along with the regular courses (PC / PE / OE / MI)

V. ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)

1. A student is eligible to register for B.Tech. (Honours) degree provided the student has:
   i. Registered at least for twelve theory courses and two ELRs in the second year.
   ii. Consistently obtained a minimum GPA of 8.5 in the first four sessions.
2. The student should Continue to maintain the same GPA of 8.5 in the subsequent sessions (including the Honours courses)

3. A student can obtain B.Tech. (Honours) degree
   i. On completion of three additional theory courses specified for the Honours degree of the programme.
   ii. On completion of all the courses registered, in the first attempt during the four years of study.

### LIST OF ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-Req.</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ICHO10</td>
<td>Design of Sensors and Transducers</td>
<td>ICPC11</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ICHO11</td>
<td>Instrumentation System Design</td>
<td>ICPC17 ICPC22</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>ICHO12</td>
<td>Micro System Design</td>
<td>ICPE12</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>ICHO13</td>
<td>Control System Design</td>
<td>ICPC21 ICPC24</td>
<td>3</td>
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<tr>
<td>5.</td>
<td>ICHO14</td>
<td>Advanced Process Control</td>
<td>ICPC21 ICPC25</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>ICHO15</td>
<td>Optimal and Robust Control</td>
<td>ICPC21 ICPC24</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>ICHO16</td>
<td>Electronics for Sensor Design</td>
<td>ICPC14 ICPC18 ICPC20</td>
<td>3</td>
</tr>
</tbody>
</table>
Programme Core (PC) Courses
ICPC10 - ENGINEERING MECHANICS

Course type: Programme Core (PC)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To introduce the fundamentals of mechanics and machines to the instrumentation and control engineering students.
2. To explain the application of basic mechanical science concepts
3. To apply different physical principles to the analysis of mechanics and machines
4. To identify the different elements of a mechanical system and write the mathematical equations for them.

Course Content:


Strain energy – Dynamic loading – Strain energy due to shear – Impact torsional loading – Strain energy due to bending – Impact loading of beams.


Degrees of freedom – Two rotor system – Forced vibrations.

Text Books:

Course outcomes:

On completion of this course, the students will be able to,

1. analyze simple mechanisms and their principles of operation.
2. write the mathematical equations for static and dynamic loading in simple mechanical systems.
3. write the equations for energy and power in simple mechanical systems.
4. analyze free and forced oscillations in simple dynamic systems.
ICPC11 - SENSORS AND TRANSDUCERS

Course type: Programme Core (PC)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To expose the students to various sensors and transducers for measuring mechanical quantities.
2. To make the students familiar with the specifications of sensors and transducers.
3. To teach the basic conditioning circuits for various sensors and transducers.
4. To introduce about advancements in sensor technology.

Course Content:

General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data.

Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: Load and torque measurement, Digital displacement sensors.

Self and mutual inductive transducers - capacitive transducers, eddy current transducers, proximity sensors, tacho-generators and stroboscope.

Piezoelectric transducers and their signal conditioning, Seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, magnetostrictive transducers.

Introduction to semiconductor sensor, materials, scaling issues and basics of micro fabrication. Smart sensors.

Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be,

1. familiar with the basics of measurement system and its input, output configuration.
2. familiar with both static and dynamic characteristics of measurement system.
3. familiar with the principle and working of various sensors and transducers.
4. able to design signal conditioning circuit for various transducers.
5. able to identify or choose a transducer for a specific measurement application.
ICPC12 - MATERIAL SCIENCE

Course type: Programme Core (PC)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To introduce the basic principles of Material Science and apply those principles to engineering applications.
2. To teach the structure, properties, advantages and limitations of engineering materials.
3. To introduce the structure-property correlations in materials to develop materials for demanding engineering applications.

Course Content:

Introduction to crystal structure of materials, density computations, polymorphism and allotropy, Miller indices for crystallographic planes and directions, isotropy and anisotropy with respect to material properties. X-ray diffraction for determination of crystal structure. Defects in solids: point, line and planar defects and their effect on properties of materials. Phase diagrams, mono component and binary systems, Interpretation of phase diagrams, the Gibbs phase rule, the iron-carbon system.


Electrical properties of materials: Electron energy band structures for solid materials, conduction in terms of band structure and atomic bonding models. Intrinsic and extrinsic semiconductors, the temperature variation of conductivity and carrier concentration. Electrical properties of polymers. Dielectric behaviour, Ferro electricity and Piezoelectricity.


Zone refining for purification of materials, Synthesis and growth of Group-III-V compounds and their applications. Selection of specific materials required for instrumentation devices, sensors, pumps, valves, pipelines and coatings.

Text Books:


Reference Books:


Course outcomes:

On completion of this course, the students will be able to,

1. identify the structure and understand the electrical, magnetic and optical properties of different materials.
2. interpret the phase diagrams and apprehend the phase transformations.
3. assess the mechanical properties of the materials using the associated testing methods.
4. select and develop materials for specific instrumentation applications.
ICPC13 - THERMODYNAMICS AND FLUID MECHANICS

Course type: Programme Core (PC)  
No. of Credits: 4

Pre-requisites: -

Course Objectives:

1. To impart knowledge about the fundamentals of thermodynamic laws, concepts and principles.
2. To introduce the principles of various cycles and to apply the thermodynamic concepts in various applications.
3. To introduce the fundamental concepts of fluid mechanics, pressure distribution and dimensional analysis.
4. To comprehend the metering and transportation of fluids and fluid moving machinery performance.

Course Content:

Basic concepts of thermodynamics: Thermodynamic equilibrium, quasi-static process, zeroth law, work and heat interactions, first law for a cycle and a process, steady flow processes, second law statements, reversibility, Carnot theorem, Clausius inequality, entropy principle. Available energy: Availability and irreversibility, properties of pure substances, phase equilibrium diagrams, Rankine cycle, reheat and regenerative cycle, properties of ideal gas, Stirling and Ericson cycles.

Heat engines: Otto, diesel and dual cycles, Brayton cycle with regeneration, inter cooling and reheat, Joule-Thompson effect.


Darcy Weisbach equation – Moody's diagram, minor losses – Boundary layer and its basic concepts.

Fluid machinery: Centrifugal pumps, Reciprocating pumps, Hydraulic ram, Impulse turbine, Reaction turbine.

Text Books:

Reference Books:


Course outcomes:

On completion of this course, the students will be able to,

1. apply the fundamentals of thermodynamics to various process.
2. understand various thermodynamic cycles and their applications to heat engines.
3. apply the knowledge of fundamental concepts in fluids mechanics and usage of dimensional analysis for scaling experimental results.
4. select the metering equipment and fluid moving machinery for an appropriate process engineering operation.
ICPC14 - CIRCUIT THEORY

Course type: Programme Core (PC)  
Pre-requisites: -  
No. of Credits: 4

Course Objectives:

1. To teach the electrical circuit laws and theorems, to aid in circuit analysis.
2. To impart problem solving technique of linear passive electrical circuits.
3. To expose the students to the transient behavior of different R-L-C circuits.
4. To teach the methods of AC circuit analysis and synthesis of 2-port networks.

Course Content:

Review of Networks and Circuits, Elemental laws (V-I characteristics) for Resistors, Inductors, and Capacitors, Circuital laws (Kirchhoff’s laws), Sign convention, Basic signals (dc and ac), Elementary signals (impulse, step, ramp, exponential), Synthesis of arbitrary waveforms (rectangular, triangular etc.) from elementary signals, Voltage and Current sources (Independent and Dependent), Ladder and Bridge Circuits.

Analysis of Resistive Circuits energized by dc voltages and currents – Source Transformations, Nodal and Mesh Analysis, Principle of Superposition, Network Theorems (Thevenin’s and Norton’s, Maximum Power Transfer), Circuits with dependent dc Sources.


Sinusoidal Sources and Response – Behaviour of elements with ac signals, Impedance and Admittance, Generalization of Network Theorems and Circuit Analysis, Introduction to 3-φ power systems. Transient and Steady-state Response of Circuits – Laplace Transform and its application to circuit analysis, State Variables, Network Functions (Driving point impedance and admittance), Transfer function, Two-port Networks, Applications of Two-port networks, Introduction to General Linear Systems.


Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be able to,

1. analyze and solve the DC and AC circuits using network theorems and mathematical tools.
2. apply the knowledge of the time domain and frequency domain characteristics of electrical circuits for design.
3. design and synthesis two port networks.
ICPC15 - DIGITAL ELECTRONICS

Course type:  Programme Core (PC)  
Pre-requisites:  -  
No. of Credits:  3

Course Objectives:

The subject aims to provide the student with

1. An understanding of number systems, codes and their conversions.
2. The capability to reduce Boolean expression using K-map and tabular methods.
3. The ability to design and analyze combinational and sequential logic circuits for a given problem statement.
4. An understanding of digital hardware, different types of logic families and their characteristics

Course Content:

Review of number systems and logic gates, Algebraic reductions, Binary codes -Weighted and non-weighted, number complements, Binary arithmetic, Error detecting and error correcting codes, SOP, POS Canonical logic forms, Karnaugh maps and Quine-McClusky methods, Don’t care conditions, minimization of multiple output functions.

Synthesis of combinational functions: Arithmetic circuits-Adder/ Subtractor, carry look-ahead adder, signed number addition and subtraction, BCD adders. IC adders. Multiplexers, implementation of combinational functions using multiplexers, de-multiplexers, decoders, code converters, Digital ICs for combinational logic circuits.


Digital Hardware: Logic levels, Realization of logic gates, different logic families (TTL, ECL, CMOS, HC, HCT, ACT and HSCMOS), Logic levels, voltages and currents, fan-in, fan-out, speed, power dissipation. Comparison of logic families, interfacing between different families.

Text Books:

Reference Books:


Course outcomes:

On completion of this course, the students will be able to,

1. understand how digital and logic computing can be arrived at from the digital number systems and codes.
2. build the digital and logic (computing) circuits from the fundamental semiconductor electronics.
3. apply the knowledge on basic logics and techniques to analyze and design digital electronic circuits.
4. develop expertise to design and implement digital circuits to be applicable for signal measurement and processing.
ICPC16 - SIGNALS AND SYSTEMS

Course type: Programme Core (PC)  
No. of Credits: 3  
Pre-requisites: -

Course Objectives:

1. This course introduces the student to identify and represent the type of signals and systems.
2. The students are introduced to the mathematical tools available to analyze the signals and systems.
3. A section of the course introduces about the random phenomena in the real world and the mathematical models.
4. To introduce about pseudo-random signals in identifying systems.

Course Content:


Representation of signals in terms of elementary signals – Condition of orthogonality – Representation of signals by elementary sinusoids – Fourier series representation of periodic signals – Power spectrum.


Auto-correlation function of system output - Cross-correlation between system input and output. White noise - Analysis of linear systems in time-domain using white noise - Mean and mean square value of system output. Generation of pseudo random binary noise (PRBN) and its use in system identification - Analysis in the frequency domain.
Text Books:


Reference Books:


Course outcomes:

On completion of this course, the students will be able to,

1. identify the types of signals and systems with general understanding of continuous time and discrete time signals and systems.
2. analyze signals and systems using transforms.
3. classify random signals using statistical concepts and characterize systems using pseudo-random signals.
ICPC17 - INDUSTRIAL INSTRUMENTATION

Course type: Programme Core (PC)  Pre-requisites: 
No. of Credits: 3

Course Objectives:

1. To expose the students to the importance of process variable measurements.
2. To expose the students to various measurement techniques used for the measurement of temperature, flow, pressure and level in process industries.
3. To make the students knowledgeable in the design, installation and trouble shooting of process instruments.

Course Content:

Temperature measurement: Introduction to temperature measurements, Thermocouple, Resistance Temperature Detector, Thermistor and its measuring circuits, Radiation pyrometers and thermal imaging.

Pressure measurement: Introduction, definition and units, Mechanical, Electro-mechanical and electronic pressure measuring instruments. Low pressure measurement, Transmitter definition types, I/P and P/I Converters.

Level measurement: Introduction, Differential pressure level detectors, Capacitance level sensor, Ultrasonic level detectors and Radar level transmitters and gauges.


Flow measurement: Hot wire anemometer, laser Doppler anemometer, ultrasonic, vortex and cross correlation flow meters, and measurement of mass flow rate.

Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be,

1. familiar with the different temperature, pressure, flow and level measurement techniques used in process industries.
2. able to select and make measurements of temperature, flow, pressure and level in any process industry.
3. able to identify or choose temperature, flow, pressure and level measuring device for specific process.
ICPC18 - ANALOG SIGNAL PROCESSING

Course type: Programme Core (PC)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

This course emphasizes intuitive understanding and practical implementations of the theoretical concepts of amplifiers, filters and other circuits which are essential for signal conditioning.

Course Content:

Introduction to analog signals and systems, Random signal analysis, application of statistical methods to the measurement of waveforms.

Analog signal processing circuits: amplifiers, analog multipliers, integrators, differentiators, active and passive filters. Universal Filters and their application

Current-to-voltage and voltage-to-current converter, analog-to-digital converter, digital-to-analog converter, voltage-to-frequency converter, frequency-to-voltage converter.

Switched capacitor filter, Phase locked loop, Schmitt trigger, automatic gain control, regulators, wave form generators, oscillators.

Case studies: bridge linearization, PLL design using divider and multipliers, regulator design with low voltage dropout, transmitter design and realization of controllers.

Text Books:


Reference Books:


Course outcomes:

On completion of this course, the students will be able to

1. understand the implications of the properties of systems and signals.
2. design and simulate various analog signal conditioning circuits.
3. implement various analog signal conditioning circuits in real time.
4. trouble shoot analog signal conditioning circuits.
ICPC19 - ELECTRICAL AND ELECTRONIC MEASUREMENTS

Course type: Programme Core (PC)  
No. of Credits: 3  
Pre-requisites: -

Course Objectives:

1. To give an overview of current, voltage and power measuring electrical, electronics and digital instruments.
2. To expose the students to the design of bridges for the measurement of resistance, capacitance and inductance.
3. To give an overview of test and measuring instruments.

Course Content:

Electrical measurements: General features and Classification of electro mechanical instruments. Principles of Moving coil, moving iron, dynamometer type, rectifier type, thermal instruments. Extension of instrument range: shunt and multipliers, CT and PT.

Measurement of Power: Electrodynamit wattmeter’s, Low Power Factor (LPF) wattmeter, errors, calibration of wattmeter. Single and three phase power measurement, Hall effect wattmeter, thermal type wattmeter.


DSO, MSO, Function generators, Signal generators, Waveform analyzers, Spectrum analyzers, Distortion analyzers, LED, LCD and Organic LED displays.

Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be,

1. familiar with various measuring instruments (ammeters, voltmeters, wattmeters, energy meters, extension of meters, current and voltage transformers) used to measure electrical quantities.
2. able to design suitable DC and AC bridges for the measurement of R, L, C and Frequency measurement.
3. able to suggest the kind of instrument suitable for typical measurements.
4. able to use the test and measuring instruments effectively.
ICPC20 - MICROPROCESSORS AND MICROCONTROLLERS

**Course type:** Programme Core (PC)  
**Pre-requisites:** ICPC15  
**No. of Credits:** 3

**Course Objectives:**

1. To introduce the architecture of 8, 16 and 32 bit microprocessor and microcontroller.  
2. To impart microcontroller programming skills in students.  
3. To familiarize the students with data transfer and interrupt services.

**Course Content:**

Introduction to computer architecture and organization, Architecture of 8-bit, 16 bit, 32-bit and 64-bit microprocessors, CISC/RISC design philosophy, bus configurations, CPU module. Embedded system overview.

Introduction to embedded C and assembly language, instruction set of a typical 8-bit and 16-bit microprocessor, subroutines and stacks, energy efficient ultra-low power modes, programming exercises.

Timing diagrams, Memory families, Flash Vs FRAM, on-chip peripherals- working with IO ports, ADC, comparators, timers, PWM, Watchdog, Low power modes.

Architectures of 8 and 16-bit Microcontrollers, comparison, programming exercises, applications of energy efficient systems.

Serial and parallel data transfer schemes, interrupts and interrupt service procedure. Internal peripherals of microcontrollers – SPI, I2C UART, USB and DNA. Interfacing with RTC, EEPROM and DAC.

**Text Books:**


**Reference Books:**


**Course outcomes:**

On completion of this course, the students will be able to,

1. understand the various functional blocks of microprocessor and microcontrollers.  
2. understand and write an assembly language program.  
3. interface the peripherals with microprocessors and microcontrollers.
ICPC21 - CONTROL SYSTEMS - I

Course type: Programme Core (PC)  
Pre-requisites: -  
No. of Credits: 4

Course Objectives:

1. To introduce the concept of feedback control system.  
2. To impart knowledge in mathematical modeling of physical systems.  
3. To impart knowledge in characteristics and performance of feedback control system.  
4. To teach a variety of classical methods and techniques for analysis and design of control systems.

Course Content:

Review of Systems, Mathematical Models – Differential Equations, Linear Approximations and Transfer Functions, Block Diagrams and Signal Flow Graphs


Frequency Response Methods, Nyquist’s Stability Criterion, Bode Plots, Performance Specifications in Frequency-Domain, Stability Margins.

Design of Lag and PID controllers in Frequency Domain, Design of Lag-Lead Controllers using time-domain and frequency-domain methods.

Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be able to

1. generate mathematical models of dynamic control system by applying differential equations.
2. analyze and characterize the behavior of a control system in terms of different system and performance parameters.
3. compute and assess system stability.
4. evaluate and analyses system performance using frequency and transient response analysis.
5. design and simulate control systems (linear feedback control systems, PID controller, and multivariable control systems), using control software, to achieve required stability, performance and robustness.
6. critically analyses and outline the dynamic response of closed loop systems.
ICPC22 - INSTRUMENTATION PRACTICES IN INDUSTRIES

Course type: Programme Core (PC)  
Pre-requisites: ICPC17  
No. of Credits: 3

Course Objectives:

1. To expose the students to requirement of standards and calibration techniques, safety mechanisms in instruments used in process industries.
2. To impart knowledge about EMI and EMC problems in industrial measurements.
3. To make the students to draw the specification of the industrial instruments and prepare the instrumentation project documents.

Course Content:

Selection and Application: Selection and application of temperature, pressure, flow and level measuring instruments.

Standards and Calibration: Introduction to standards and calibration, calibration of temperature, pressure and flow measuring devices. Introduction to ISO, IEC and API standards pertaining to temperature, pressure and flow instrumentation.

EMI and EMC: Introduction, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding.

Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures-NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety.


Text Books:


Reference Books:


Course outcomes:

On completion of this course, the students will be able to,

1. select the appropriate instrument for a given process measurement problem.
2. identify and classify the use of instruments in process industries according to the safety practices in industry.
3. prepare instruments specification and understand the procedure and process involved in project documentation.
ICPC23 - PRINCIPLES OF COMMUNICATION SYSTEMS

Course type: Programme Core (PC)  
No. of Credits: 3

Course Objectives:

1. To introduce the concept of communication systems.
2. To impart knowledge in the different methods of analog and digital communications and their significance.
3. To make students familiar with various sources of noise and its characteristics.

Course Content:


Principles of angle modulation: frequency and phase modulation, narrow and wide band FM, generation and demodulation of FM signals. FM transmitter and Receiver.

Pulse modulation systems- Sampling theorem, Pulse Amplitude Modulation (PAM), Pulse width modulation (PWM), Pulse time modulation (PTM): PDM and PPM. TDM systems.

Pulse code modulation- Pulse Code Modulation - quantization - PCM systems- DPCM and Delta modulation. Digital modulation schemes: ASK-PSK-FSK-Generation and detection

Noise-Source and classification, atmospheric noise, thermal noise and shot noise. Noise equivalent bandwidth, noise figure and equivalent noise temperature of a two terminal network.

Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be able to,

1. explain the basic concepts of communication systems.
2. establish understanding of various analog and digital modulation techniques and demodulation techniques.
3. describe different types of noise and calculate the noise equivalent bandwidth and noise figure of a two-port network.
ICPC24 - CONTROL SYSTEMS – II

Course type: Programme Core (PC)  
Pre-requisites: ICPC21  
No. of Credits: 3

Course Objectives:

1. To introduce about the system states and state space; System representation in states space form.
2. To teach the advanced methods and techniques of linear system analysis and Lyapunov stability.
3. To impart knowledge in the control techniques for design of a larger scale of systems.

Course Content:


Analysis of Linear State Equations – First order scalar differential equations, System modes and modal decomposition, State Transition Matrix, Time-varying matrix case.


Text Books:


Reference Books:


Course outcomes:

On completion of this course, the students will be,

1. exposed to an appropriate modern paradigm for the study of larger scale multi-input-multi-output systems.
2. able to use linear algebra and matrix theory in the analysis and design of practical control systems.
3. able to determine the stability of systems using Lyapunov’s theory.
4. motivated to implement modern control systems using a digital computer.
ICPC25 - PROCESS CONTROL

Course type: Programme Core (PC)  
Pre-requisites: ICPC21
No. of Credits: 4

Course Objectives:

1. To introduce the terminology, concepts and practices in process modeling and automatic process control.
2. To impart knowledge in the design of control systems and PID controller tuning for processes.
3. To impart knowledge in concepts of advanced process control.

Course Content:


Advanced control system: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, interaction of control loops. Introduction to Dynamic Matrix Control. Case Studies: Distillation column, boiler drum level control and chemical reactor control.

Text Books:


Reference Books:


Course outcomes:

On completion of this course, the students will be,

1. familiar with process modelling.
2. able to select and design PID controller for any process, adopting suitable tuning methodology.
3. able to comprehend about the advanced process control strategies.
ICPC26 - PRODUCT DESIGN AND DEVELOPMENT (THEORY)

Course type: Programme Core (PC) Pre-requisites: -
No. of Credits: 2

Course Objectives:

1. The aim of this course is to inculcate into the student the spirit of innovation and entrepreneurship. This is achieved in this course by making the students to develop a marketable product on their own as a group. At the end of this two semester course, the students will learn how to know the needs of the society and solve them using the technical knowledge at their disposal.

2. In this semester the students will learn some of the general concepts needed for new product development and simultaneously learn how to interact with the society outside the campus to learn about its needs. They also learn about how to get prototypes fabricated outside the campus.

Course Content:

TOPICS COVERED BY LECTURES


PRACTICAL WORK

Interaction with public outside the campus- identifying customer needs- product selection based on customer needs- concept generation- concept testing.

Identifying fabrication requirements- Identifying fabricators for the project- costing- financial model for the product development- finding outside finance for product development if possible - patent search for the product.

SUMMER VACATION WORK

Students shall actively get information about fabrication of their product prototype, especially if it involves outside fabrication units. If they have decided on the final design, they may start work on their alpha prototypes.

Course Evaluation:

Only the theoretical component will be evaluated during this semester. The practical component is evaluated at the end of the next semester.

Text Books:

ICPC27 - PRODUCT DESIGN AND DEVELOPMENT (PRACTICE)

Course type: Programme Core (PC)  
No. of Credits: 2

Pre-requisites:

Course Objectives:

1. The aim of this course is to inculcate into the student the spirit of innovation and entrepreneurship. This is achieved in this course by making the students to develop a marketable product on their own as a group. At the end of this two semester course, the students will learn how to know the needs of the society and solve them using the technical knowledge at their disposal.

2. In this semester the students will fabricate an alpha prototype and test it for its conformity to the design specifications. After demonstration of the alpha prototype, they proceed to fabricate a beta prototype that is acceptable in the market-place.

Practical work:

1. Alpha prototype fabrication and testing
2. Beta prototype fabrication and customer acceptance survey

Course outcomes:

On completion of this course, the students will be able to,

1. make market surveys for new product development
2. plan the entire cycle of new product design and development.
3. fabricate prototypes of new products and test them.
ICPC28 - ANALYTICAL INSTRUMENTATION

Course type: Programme Core (PC)  
Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To teach the students about the analysis of materials which is an important requirement of process control and quality control in industry.
2. To expose the students to principles of various analytical methods.
3. The impart knowledge on various instruments used in the analysis of materials.

Course Content:


Text Books:

Reference Books:


Course outcomes:

On completion of this course, the students will be able to,

1. appreciate the relevance of material sampling and analysis in process control and quality control in industry.
2. understand the physical principles behind the various widely used analytical methods in the industry.
3. select an appropriate analytical instrument for an industrial requirement.
ICPC29 - LOGIC AND DISTRIBUTED CONTROL SYSTEMS

Course type: Programme Core (PC)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To introduce the importance of process automation techniques.  
2. To impart knowledge in PLC based programming.  
3. To introduce distributed control system and different communication protocols.

Course Content:

Review of PC based control design for process automation: Functional Block diagram of Computer control of process - Mathematical representation – Sampling Consideration- Data Acquisition system and SCADA, Hybrid, Direct Digital Control System, Distributed Control system architecture and Comparison with respect to different performance attributes.

Programmable logic controller (PLC) basics: Definition, overview of PLC systems, Block diagram of PLC. General PLC programming procedures: ON/OFF instruction, Timer instruction sets, Counter Instruction sets -Design, development and simulation of PLC programming using above instruction sets for simple applications.

PLC Data manipulation instruction - Arithmetic and comparison instruction- Skip, Master Control Reset (MCR) and Zone Control Last state (ZCL) instruction – PID and other important instruction set. PLC Installation, troubleshooting and maintenance. Design of alarm and interlocks, networking of PLC – Case studies using above instruction sets.

Distributed Control system: Local Control Unit (LCU) architecture - Comparison of different LCU architectures – LCU Process Interfacing Issues: - Block diagram, Overview of different LCU security design approaches, secure control output design, Manual and redundant backup designs.

LCU communication Facilities - Communication system requirements – Architectural Issues – Operator Interfaces – Engineering Interfaces. Development of Field Control Unit (FCU) diagram for simple control applications. Introduction to HART and Field bus protocol. Interfacing Smart field devices (wired and wireless) with DCS controller. Introduction to Object Linking and Embedding (OLE) for Process Control, Automation in the cloud with case studies.

Text Books:


Reference Books:


Course outcomes:

On completion of this course, the students will be,

1. familiar with process automation technologies.
2. able to design and develop a PLC ladder programming for simple process applications.
3. able to apply different security design approaches, engineering and operator interface issues for designing of Distributed control system.
4. familiar with latest communication technologies like HART and Field bus protocol.
Programme Elective (PE) Courses
ICPE10 - OPTICAL INSTRUMENTATION

**Course type:** Programme Elective (PE)  
**Pre-requisites:** -  
**No. of Credits:** 3

**Course Objectives:**

1. To expose to the students on the basics of optical sources and detectors, optical fiber and fiber optic sensors.
2. To impart knowledge on the characteristics of optical sources and detectors.
3. To introduce about the Industrial applications of fiber optic sensors and lasers.

**Course Content:**

Introduction: Characteristics of optical radiation, luminescence.

Optoelectronic sources:
LED – LED power and efficiency, structures- planar, dome, ELED, SLED, super luminescent LEDs, characteristics and applications.
LASERS – structures- gain guided and index guided lasers, types- semiconductor- homo and hetero junction lasers. Non-semiconductor lasers - gas, liquid and solid. Single frequency Lasers, characteristics, Q switching and mode locking, cavity dumping.

Optoelectronic detectors: General characteristics of photodetectors, Photodiode, junction photodiodes – heterojunction diode and PIN diode, APD, Special detectors- Schottky barrier diode, photo- transistor and photo-thyristor, solar cells.

Optical fiber- Fundamentals, types, transmission characteristics. Fibers splicing, connector and couplers. Optocouplers and optrodes.

Industrial applications –
Fiber optic sensors -temperature, pressure, flow and level measurement.
LASERS – Distance, length, velocity, acceleration, current and voltage measurements. Material processing: Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporisation, calculation of power requirements. Laser gyroscope.

**Text Books:**


**Reference Books:**


Course Outcomes:

On completion of the course the students will be,

1. familiar with the fundamental principles of various types of optical sources, characteristics and its applications.
2. able to understood the operation of different types of optical detectors and its limitations in industrial use.
3. knowledgeable on fiber-optical components and systems and its industrial applications.
ICPE11 - MEDICAL INSTRUMENTATION

Course Type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

The course gives an introduction to the human physiological system with respect to medical instrumentation and its design and the instrumentation for measuring and analyzing the physiological parameters.

1. To educate the students on the different medical instruments.  
2. To familiarise the students with the analysis and design of instruments to measure bio signals like ECG, EEG, EMG, etc.  
3. To introduce about the applications of biomedical instrumentation.

Course Content:

Electro physiology: Review of physiology and anatomy, resting potential, action potential, bioelectric potentials, cardiovascular dynamics, electrode theory, bipolar and uni-polar electrodes, surface electrodes, physiological transducers. Systems approach to biological systems.

Bioelectric potential and cardiovascular measurements: Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques. Heart sound measurement - stethoscope, phonocardiograph. EMG - Evoked potential response, EEG, foetal monitor. ECG, phonocardiography, vector cardiograph, impedance cardiology, cardiac arrhythmia’s, pace makers, defibrillators.

Respirator and pulmonary measurements and rehabilitation: Physiology of respiratory system, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotherapy, diathermy, nerve stimulator, Heart lung machine, Haemodialysis, ventilators, incubators, drug delivery devices, therapeutic applications of the laser.

Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems, patient monitoring through telemedicine, implanted transmitters, telemetering multiple information. Sources of electrical hazards and safety techniques.

Medical imaging systems: X ray machine, Computer tomography, ultrasonic imaging system, magnetic resonance imaging system, thermal imaging system, positron emission tomography.

Text Books:

Reference Books:


Course Outcomes:

On completion of this course the students will be,

1. able to understand, design and evaluate systems and devices that can measure, test and/or acquire biological information from the human body.
2. familiar with patient monitoring equipment used in hospitals and in telemedicine.
3. familiar with various imaging techniques used for diagnosis.
ICPE12 - MICRO ELECTRO MECHANICAL SYSTEMS

Course Type: Programme Elective (PE)  Pre-requisites: ICPC11
No. of Credits: 3

Course Objectives:

1. To introduce the concepts of microelectromechanical devices.
2. To introduce the state-of-art micromachining techniques including surface micromachining, bulk micromachining, and related methods.
3. To provide knowledge in the design concepts of micro sensors and micro actuators.
4. To provide knowledge about computer aided design tools for modeling MEMS device.

Course Content:

Introduction, emergence, MEMS application, scaling issues, materials for MEMS, Thin film deposition, lithography and etching.

Bulk micro machining, surface micro machining and LIGA process.


Theory and design: Micro Pressure Sensor, micro accelerometer – capacitive and piezoresistive, micro actuator.

Electronic interfaces, design, simulation and layout of MEMS devices using CAD tools.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course the students will be able to,

1. understand the fundamental principles behind the working of micro devices/ systems and their applications.
2. gain a fundamental understanding of standard micro fabrication techniques.
3. apply knowledge of micro fabrication techniques to design a MEMS device or a microsystem.
4. acquire skills in computer aided design tools for modeling and simulating MEMS device.
ICPE13 - AUTOMOTIVE INSTRUMENTATION

Course type: Programme Elective (PE)  
Pre-requisites: ICPC11, ICPC17  
No. of Credits: 3

Course Objectives:

1. To impart knowledge on automobile system, its subsystems and components.
2. To expose the students to the concepts of various sensors used in automobile systems.
3. To teach the basic and advanced controls in automotive systems.
4. To impart knowledge about the electronics and software involved in automotive systems.

Course Content:

Introduction of automobile system:  
Current trends in automobiles with emphasis on increasing role of electronics and software, overview of generic automotive control ECU functioning, overview of typical automotive subsystems and components, AUTOSAR.

Engine management systems:  
Basic sensor arrangement, types of sensors such as oxygen sensors, crank angle position sensors, Fuel metering/ vehicle speed sensors, flow sensor, temperature, air mass flow sensors, throttle position sensor, solenoids etc., algorithms for engine control including open loop and closed loop control system, electronic ignition, EGR for exhaust emission control.

Vehicle power train and motion control:  
Electronic transmission control, adaptive power steering, adaptive cruise control, safety and comfort systems, anti-lock braking, traction control and electronic stability, active suspension control.

Active and passive safety system:  
Body electronics including lighting control, remote keyless entry, immobilizers etc., electronic instrument clusters and dashboard electronics, aspects of hardware design for automotive including electro-magnetic interference suppression, electromagnetic compatibility etc., (ABS) antilock braking system, (ESP) electronic stability program, air bags.

Automotive standards and protocols:  
Automotive standards like CAN protocol, LIN protocol, FLEX RAY, Head-Up Display (HUD), OBD-II, CAN FD, automotive Ethernet etc. Automotive standards like MISRA, functional safety standards (ISO 26262).

System design and energy management:  
BMS (battery management system), FCM (fuel control module), principles of system design, assembly process of automotives and instrumentation systems.
Text Books:


Reference Books:


Course Outcomes:

On the completion of this course the students will be able to,

1. identify the automotive system and its components.
2. attain knowledge of various sensors and conditioning circuit used in automotive systems.
3. gain knowledge about various control strategies, the electronics and software used in automotive application.
ICPE14 - INSTRUMENTATION AND CONTROL FOR POWER PLANT

Course type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To expose the students to various power generation methods.
2. To impart knowledge on various processes/systems involved in thermal power generation.
3. To provide the knowledge on specific measurement techniques and control systems practiced in boiler and turbine units.
4. To impart basic knowledge in nuclear power plant and associated instrumentation.

Course Content:

Brief survey of methods of power generation-hydro, thermal, nuclear, solar and wind power –  

Measurement in boiler and turbine: Metal temperature measurement in boilers, impulse piping system for pressure measuring devices, flame monitoring. Introduction to turbine supervising system, pedestal vibration, shaft vibration, eccentricity measurement. Installation of non-contracting transducers for speed measurement, rotor and casing movement and expansion measurement.

Controls in boiler: Problems associated with control of multiple pulverizers. Draught plant: Introduction, natural draught, forced draught, induced draught, balanced draught, power requirements for draught systems. Fan drives and control, control of air flow. Combustion control: Fuel/Air ratio, oxygen, CO and CO₂ trimming, combustion efficiency, excess air, parallel and cross limited combustion control, control of large systems.

Controls in boiler: Boiler drum level measurement methods, feedwater control, soot-blowing operation, steam temperature control, Coordinated control, boiler following mode operation, turbine following mode operation, constant / sliding pressure operation, selection between boiler and turbine following modes. Distributed control system in power plants-interlocks in boiler operation. Turbine control: Shell temperature control-steam pressure control – lubricant oil temperature control – cooling system.

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types of nuclear power plant, Nuclear reactor control loops, reactor dynamics, excess reactivity, pulse channel and logarithmic instrumentation, control and safety instrumentation, reliability aspects.
Text Books:


Reference Books:


Course Outcomes:

On the completion of this course, the students will be familiar with,

1. various power generation processes.
2. important parameters to be monitored and controlled in a thermal power plant.
3. major control systems involved in the thermal power plant and nuclear power plants.
ICPE15 - INSTRUMENTATION AND CONTROL FOR PETROCHEMICAL INDUSTRIES

**Course type:** Programme Elective (PE)  
**Pre-requisites:** -  
**No. of Credits:** 3

**Course Objectives:**

1. To expose the students to various petroleum production processes.
2. To impart knowledge on various processes involved in petroleum refinery.
3. To provide knowledge on specific measurement techniques practiced, control systems and automation involved in petrochemical industry.

**Course Content:**

Brief survey of petroleum formation, petroleum exploration, Petroleum production, Petroleum refining and its methods, Refining capacity and consumption in India, constituents of Crude Oil, Recovery techniques – Oil – Gas separation, Processing wet gases.

P & I diagram of petroleum refinery, Atmospheric distillation process, Vacuum distillation process, Thermal cracking, Catalytic cracking, Catalytic reforming, and Utility plants – Air, N₂, and cooling water.

Basics of field instruments, Parameters to be measured in Petrochemical industry, Distillation Column control, Selection of instruments, Basics of intrinsic safety of instruments, Area classification.

Control of furnace, Reboiler Control, Reflux Control, Control of catalytic crackers, Control of heat exchanger, Control of cooling tower.


**Text Books:**


**Reference Books:**

Course Outcomes:

On completion of this course, the students will be familiar with,

1. various petrochemical process and important parameters to be monitored and controlled.
2. various instruments involved in and the control of petrochemical process.
3. the automation and safety standards of a petrochemical industry.
ICPE16 - INSTRUMENTATION AND CONTROL FOR PAPER INDUSTRIES

Course type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To familiarize the students to the paper making process.  
2. To expose the students to the instrumentation used in Paper industries.  
3. To expose the students to the control operations employed in paper industries.

Course Content:

Paper making process: Raw materials, pulping and preparation, screening – bleaching, cooking, chemical addition, approach system, paper machine, drying section, calenders, drive, finishing, other after treatment processes, coating.  
Properties of paper: physical, electrical, optical and chemical properties.

Wet end Instrumentation: Conventional measurements at wet end, pressure and vacuum, temperature, liquid density and specific gravity, level, flow, consistency measurement, pH and ORP measurement, freeness measurement.

Dry end Instrumentation: Conventional measurements, moisture, basis weight, caliper, coat thickness, optical variables, measurement of length and speed.  
Digester: Rotary and Batch type.

Control aspects: Machine and cross direction control techniques, control of pressure, vacuum, temperature, liquid density and specific gravity, level, flow, pH, freeness, thickness, consistency, basis weight and moisture.

Pumps and control valves used in paper industry, flow box and wet end variables, evaporator feedback and feed forward control, lime mud density control, stock proportioning system, refiner control instrumentation, basic pulper instrumentation, headbox – rush/drag control. Instrumentation for size preparation, coating preparation, coating weight control. Batch digester, K/Kappa number control, Bleach plant chlorine stage control.

Text Books:

Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. appreciate the need of instrumentation and control in paper making.
2. understand the instrumentation and control used in paper and pulp industry.
3. suggest and analyse new instruments and control options in paper and pulp industry.
ICPE17 - INSTRUMENTATION FOR AGRICULTURAL AND FOOD PROCESSING INDUSTRIES

Course type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To provide an understanding on the need of instrumentation in agriculture and food processing sector.
2. To provide an understanding of food quality assessment and instruments used for the same.
3. To provide an understanding on agriculture associated activities and instruments used for the same.
4. To provide some knowledge in food processing equipments.

Course Content:

Introduction: Necessity of instrumentation and control for food processing and agriculture sensor requirement, remote sensing, biosensors in Agriculture, standards for food quality.

Instrumentation for food quality assurance: Instrumental measurements and sensory parameters. Inline measurement for the control of food processing operations: color measurements of food, food composition analysis using infrared, microwave measurements of product variables, pressure and temperature measurement in food process control, level and flow measurement in food process control, ultrasonic instrumentation in food industry. Instrumental techniques in the quality control, Major Processes: Flow diagram of sugar plant, sensors and instrumentation set-up for it, Oil extraction plant and instrumentation set-up, Juice extraction control set-up.


Green houses and Instrumentation: Ventilation, cooling and heating wind speed, temperature and humidity, rain gauge, carbon dioxide enrichment measurement and control.

Design considerations of agricultural and food Processing Equipments: Design of Food Processing equipments, dryers, design of dryers PHTC, RPEC, LSU and Drum Dryer, determination of heat and air requirement for drying grains.

Text Books:

Reference Books:


Course Outcomes:

On completion of this course, the students will be,

1. able to understand the necessity of instrumentation in agriculture and food processing.
2. familiarized with instrumentation requirement in agriculture and food processing.
3. able to analyse and design systems/instruments for agriculture and food processing.
4. able to understand problems in agriculture and food processing and provide technological solution to the same.
ICPE18 – INTRODUCTION TO CHEMICAL PROCESSES

**Course type:** Programme Elective (PE)  
**Pre-requisites:** -  
**No. of Credits:** 3

**Course Objectives:**

1. To expose the student to the broad spectrum of operations in the chemical engineering field.  
2. To impart concepts of unit operations, heat mass and momentum transfer.  
3. To introduce mass transfer concept and basics of fluid flow equipments.

**Course Content:**

**Concept of unit operations:**

Unit processes and equipment’s, comminution, mixing and separations. Mechanical operations Principles and equipment. Concepts of equilibrium and rate.

**Heat mass and momentum transfer:**


**Mass transfer concept of staged processes:**

Process principles of distillation, absorption. Adsorption, humidification, drying and crystallization.

**Fluid Flow Equipment**


**Case studies of operations**


**Text Books:**


**Course Outcome:**

On completion of this course, the students will be knowledgeable in,

1. operations of various process in chemical industry.  
2. the basics of heat mass and momentum transfer.  
3. the operation of various fluid flow equipments used in chemical industries.
ICPE19 – MEASUREMENT DATA ANALYSIS

Course type: Programme Elective (PE)  
Pre-requisites: -  
No.of Credits: 3

Course Objectives:

1. To expose the students about the methods for estimating errors and uncertainties of real measurements: measurements that are performed in industry, commerce and experimental research.
2. To introduce the fundamental techniques of measurement and data analysis and to report the results of an experiment.

Course Content:

General information about measurements, measuring instruments and their properties.


Direct measurements: Method for calculating the errors and uncertainties, Methods for combining systematic and random errors.

Indirect measurements: Correlation coefficient and its calculation, the method of reduction, method of transformation, errors and uncertainty of indirect measurement. Examples of measurements and measurement data processing.

Combined Measurements:
Method of least squares, linearization of nonlinear conditional equations, and determination of the parameters in formulas from empirical data and construction of calibration curves. Combining the results of measurements. Calculation of the errors of measuring instruments.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course, the students will be able to,

1. estimate measurement inaccuracies.
2. evaluate the measurement system based on its quality and cost.
3. acquire both theoretical knowledge and practical skills in working with measurement data.
4. design and conduct experiments to analyze and interpret the data and generate reports.
ICPE20 - BUILDING AUTOMATION

Course type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To introduce the basic blocks of Building Management System.  
2. To impart knowledge in the design of various sub systems (or modular system) of building automation.

Course Content:

Introduction:  
Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

HVAC system:  
Different components of HVAC system like heating, cooling system, chillers, AHUs, compressors and filter units and their types. Design issues in consideration with respect to efficiency and economics, concept of district cooling and heating.

Access control & security systems:  
Concept of automation in access control system for safety, Physical security system with components, Access control components, Computer system access control – DAC, MAC, and RBAC.

Fire & alarm system:  
Different fire sensors, smoke detectors and their types, CO and CO2 sensors, Fire control panels, design considerations for the FA system concept of IP enabled fire & alarm system, design aspects and components of PA system.

CCTV system & energy management system:  
Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system, concept of energy management system, occupancy sensors, fans & lighting controller. Introduction to structural health monitoring and methods employed.

Text Books:

Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. understand the concept behind building automation.
2. plan for building automation.
3. design sub systems for building automation and integrate those systems.
ICPE21 - DIGITAL CONTROL SYSTEMS

Course type: Programme Elective (PE)  Pre-requisites: ICPC24
No. of Credits: 3

Course Objectives:

1. To impart knowledge in the significance and features of design of discrete-time control system.
2. To review on the different transform techniques for digital control system design.
3. To impart knowledge on the techniques to analyse the system performance in the discrete-time domain.
4. To impart knowledge in discrete state space controller design.

Course Content:

Introduction to digital control
Configuration of basic digital control system, discrete transfer function, discrete model sampled data systems using z-transform, transfer function model, signal analysis and dynamic response, zero-order hold equivalent, introduction to first-order-hold equivalent, transformation between s-plane, z-plane and w-plane, z-Domain description of sampled continuous-time systems.

Controller design
Controller Design using transform techniques: Root locus and frequency domain analysis compensator design.

State space theory
Control system analysis using state variable method, vector and matrices, state variable representation, conversion of state variable to transfer function and vice versa, conversion of transfer function to canonical state variable models, system realization, solution of state equations. Solution of discrete-time state equation. Computational methods.

State space design
Design using state-space methods: controllability and observability, control law design, pole placement, pole placement design using computer aided control system design (CACSD).

Observer design
Full order and reduced order discrete observer design - Kalman filter and extended Kalman filter design.

Stability analysis
Stability analysis and Jury's stability criterion, Lyapunov stability analysis to linear systems and discrete systems, Stability improvement by state feedback.
Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. analyze the performance and stability of a discrete-time control system.
2. design discrete controllers for continuous-time system using classical methods.
3. design discrete controllers for continuous-time system using state space technique.
4. develop discrete state space observer.
ICPE22 - NEURAL NETWORKS AND FUZZY LOGIC

Course type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To provide an overview of intelligent techniques.  
2. To introduce different architectures and algorithms of Neural Networks.  
3. To impart knowledge on Fuzzy set theory and Fuzzy rules.

Course Content:

Introduction to fuzzy logic and neural networks, Classification, Merits and demerits of intelligent techniques compared to conventional techniques. Need of an intelligent techniques for real world Engineering applications.


Neural networks for control systems: Schemes of Neuro-control, identification and control of dynamical systems, case studies.

Fuzzy set and operations, Fuzzy relations, Fuzzifications, Fuzzy rule based systems, defuzzification, fuzzy learning algorithms.

Fuzzy logic for control system with case studies. Introduction to neuro-fuzzy system and genetic algorithm.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course, the students will be,

1. familiar with the basic concepts of Neural Network and Fuzzy logic.
2. able to develop Neural Network based modelling and control for different process applications.
3. able to design Fuzzy logic based control system for process applications.
ICPE23 – NONLINEAR CONTROL

Course type: Programme Elective (PE)  
Pre-requisites: ICPC24  
No. of Credits: 3

Course Objectives:

1. To introduce and elaborate the characteristics of nonlinear systems  
2. To teach the methods to analyze nonlinear systems.  
3. To impart knowledge in the stability analysis of nonlinear systems using Lyapunov method.  
4. To teach the control methods as applicable to nonlinear systems with case studies.

Course Content:

Nonlinear system analysis: Concepts of phase plane analysis: phase portraits, construction of phase portrait, singular points, phase plane analysis of linear system and nonlinear system-existence of limit cycles.

Describing function analysis: describing function fundamentals-computing describing functions, common nonlinearities in control systems, describing functions of common nonlinearities, and describing functions analysis of nonlinear systems-stability analysis.

Lyapunov theory: Lyapunov’s Direct method, stability analysis based on Lyapunov’s direct method, Krasovskii’s method, variable gradient method.

Lyapunov analysis of Non-Autonomous system. Nonlinear control system design, feedback linearization. Passivity, Nonlinear Control, and Geometric Methods.

Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. differentiate between linear and nonlinear systems and their behaviour.  
2. apply the various methods of describing nonlinear systems and analyze the performance.  
3. evaluate the stability using the Lyapunov theory.  
4. decide the control method and design suitable nonlinear control system.
ICPE24 – SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

**Course type:** Programme Elective (PE)  
**Pre-requisites:** ICPC24  
**No. of Credits:** 3

**Course Objectives:**

1. To impart knowledge about the importance of system identification and adaptive control.
2. To teach about the parametric and nonparametric model for system identification and estimation techniques.
3. To expose students to the design of adaptive control technique.

**Course Content:**


Nonparametric model estimation: Estimates of the plant impulse, step and frequency responses from identification data, Correlation and spectral analysis for non-parametric model identification, parametric models-Equation error, output error models, and determination of model order.

Prediction-Error Model Structures: Parametric estimation using one-step ahead prediction error model structures and estimation techniques (Least Square (LS)- convergence, consistency, Bias, Instrumental Variable, Correlation function LS, generalized LS) for ARX, ARMAX, Box-Jenkins, FIR, Output Error models. Residual analysis for determining adequacy of the estimated models. Recursive system identification


Adaptive Smith predictor control, Auto-tuning and self-tuning Smith predictor. Case study-Online and offline Identification and design of adaptive control for different process.

**Text Books:**

Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. identify the model structure & order determination for an unknown process.
2. apply estimation techniques for parametric & nonparametric models.
3. develop an adaptive control schemes for time varying systems.
ICPE25 - FAULT DETECTION AND DIAGNOSIS

Course type: Programme Elective (PE)  
Pre-requisites: ICPC21  
No. of Credits: 3

Course Objectives:

1. To impart knowledge in fault detection and identification.
2. To introduce different structure residual technique for the fault identification.
3. To introduce different directional residual technique for the fault identification.

Course Content:

Introduction to Fault Detection and Diagnosis: Scope of FDD: Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications.


Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. identify the different type of faults occurred in a system.
2. apply mathematical techniques to detect faults.
3. apply structured and directional techniques for FDI design.
ICPE26 - COMPUTATIONAL TECHNIQUES IN CONTROL ENGINEERING

Course type: Programme Elective (PE)  
Pre-requisites: ICPC24  
No. of Credits: 3

Course Objectives:

1. To impart knowledge with an emphasis on control system design in the current computer era.  
2. To teach the interdisciplinary necessity of linear algebra, control theory, and computer science.  
3. To discuss about algorithms useful for practicing engineers for easy implementation on a range of computers.

Course Content:


Numerical Linear Algebra – Floating point numbers and errors in computations, Conditioning, Efficiency, Stability, and Accuracy, LU Factorization, Numerical solution of the Linear system $Ax = b$, QR factorization, Orthogonal projections, Least Squares problem, Singular Value Decomposition, Canonical forms obtained via orthogonal transformations.


Large scale Matrix computations, Some Selected Software – MATLAB, MATHEMATICA, SCILAB.

Text Books:


Reference Books:

1. www.scilab.org
Course Outcomes:

On completion of this course, the students will,

1. acquire skills and numerical solutions of state equations and frequency response computations.
2. be able to develop numerical algorithms for evaluation of controllability, observability, and stability.
3. acquire skills in numerical solutions for conditioning of Lyapunov and algebraic Riccati equation
4. be able to obtain large-scale solutions of control problems.
ICPE27 - PROCESS MODELLING AND OPTIMIZATION

Course type: Programme Elective (PE)  
Pre-requisites: ICPE18

No. of Credits: 3

Course Objectives:

1. To introduce different modelling techniques both analytical and model driven.
2. To impart knowledge in objective function formulation and optimization techniques.
3. To familiarize students with the use of optimization tools in process modelling and simulation.

Course Content:

Definition of process model, physical and mathematical modeling, deterministic and stochastic process, classification of models, model building, black-box model, white box model, gray model, classification of mathematical methods.

Mathematical models of chemical engineering systems: Introduction, uses of mathematical models, scope of coverage, principles of formulation, fundamental laws, continuity equations, energy equations, equation of motion, transport equation, equation of state, equilibrium, kinetics. Examples of mathematical models of chemical engineering systems

The nature and organization of optimization problems: Scope and hierarchy of optimization, examples of applications of optimization, the essential features of optimization problems, general procedure for solving optimization problems, obstacles to optimization.

Developing models for optimization: Classification of models, selecting functions to fit empirical data, factorial experimental designs, degrees of freedom, formulation of the objective function. Basic concepts of optimization: Continuity of function, NLP problem statement, convexity and its applications, interpretation of the objective function in terms of its quadratic approximation, necessary and sufficient conditions for an extremum of an unconstrained function.

Optimization of unconstrained functions: One-dimensional search numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton and Quasi-Newton methods of uni-dimensional search, polynomial approximation methods, how one-dimensional search is applied in a multidimensional problem, evaluation of uni-dimensional search methods. Application of optimizations: Examples of optimization in chemical processes.

Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. use process models based on conservation principles and process data.
2. simulate the chemical processes.
3. apply the computational techniques to solve the process models.
4. utilize the principles of engineering to develop equality and inequality constraints.
5. know about and use optimization as a tool in process design and operation.
ICPE28 – CONTROL SYSTEM COMPONENTS

Course type: Programme Elective (PE)  
No. of Credits: 3

Pre-requisites:

Course Objectives:

1. To expose the students to various electrical and mechanical components used in industrial control systems.
2. To teach various mechanical and pneumatic systems used in industrial control systems.
3. To introduce the concept of hydraulic pumps, actuators and valves.

Course Content:

Motors:
Types, working principle, characteristic, and mathematical model of following: Motors AC/DC motors, Brushless DC motors, stepper, servo, linear, Synchronous, Generators, and Alternator

Types, working principle, characteristics, and symbolic representation of following: Switches: Toggle, Slide, DIP, Rotary, Thumbwheel, Selector, Limit, Proximity, Combinational switches, zero speed, belt sway, pull cord. Relays: Electromechanical, Solid state relays, relay packages
Contactors: Comparison between relay & contactor, contactor size and ratings
Timers: On Delay, off delay and Retentive

Sequencing & Interlocking for motors: Concept of sequencing & Interlocking, Standard symbols used for Electrical Wiring Diagram, Electrical Wiring diagrams for Starting, Stopping, Emergency shutdown, (Direct on line, star delta, soft starter) Protection devices for motors: Short circuit protection, Over load Protection, Over/ under voltage protection, Phase reversal Protection, high temperature and high current Protection, over speed, Reversing direction of rotation, Braking, Starting with variable speeds, Jogging/Inching Motor Control Center: Concept and wiring diagrams

Pneumatic components: Pneumatic Power Supply and its components: Pneumatic relay (Bleed & Non bleed, Reverse & direct), Single acting & Double acting cylinder, Special cylinders: Cushion, Double rod, Tandem, Multiple position, Rotary Filter Regulator Lubricator (FRL), Pneumatic valves (direction controlled valves, flow control etc), Special types of valves like relief valve, pressure reducing etc. Hydraulic components: Hydraulic supply, Hydraulic pumps, Actuator (cylinder & motor), Hydraulic valves

Text Books:

Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. select and use the components for electrical systems.
2. identify, formulate and solve a problem using pneumatic system in instrumentation and control engineering.
3. identify, formulate and solve a problem using hydraulic system in instrumentation and control engineering.
ICPE29 – NETWORK CONTROL SYSTEMS

Course type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To impart knowledge in different network models.  
2. To introduce different network control system techniques.  
3. To introduce different applications suited for network control systems.

Course Content:


Decentralized Control - limited computational, communications, and controls resources in networked control systems.

Multi-Agent Robotics - formation control, sensor and actuation models.

Mobile Sensor Networks - coverage control, voronoi-based cooperation strategies.

Mobile communications networks, connectivity maintenance.

Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. design control system in the presence of quantization, network delay or packet loss.  
2. understand distributed estimation and control suited for network control system.  
3. develop simple application suited for network control systems.
ICPE30 - DIGITAL SIGNAL PROCESSING

Course type: Programme Elective (PE)  
Pre-requisites: ICPC16  
No. of Credits: 3

Course Objectives:
1. To provide higher level of understanding of discrete-time and digital signal in time and frequency domains.  
2. To provide knowledge to analyze linear systems with difference equations  
3. To design and implement different structures of FIR and IIR filters.  
4. To introduce about DSP processors and FFT processors.

Course Content:


IIR Filters: Design of analog prototype filters, Analog frequency transformations, Impulse invariance method and digital frequency transformations, Bilinear transformation, Analog prototype to digital transformations, Difficulties in direct IIR filter design, Comparisons with FIR filters.

Filter Realization: Structures for FIR filters, Structures for IIR filters, State-space analysis and filter structures, Fixed point and floating-point representation of numbers, Errors resulting from rounding and truncating, Quantization effects of filter coefficients, Round-off effects of digital filters.

DSP Processors: Computer architectures for signal processing – Harvard architecture and pipelining, General purpose digital signal processors, Selection of DSPs, Implementation of DSP algorithms on a general purpose DSP, Special purpose hardware – hardware digital filters and hardware FFT processors, Evaluation boards for real-time DSP.

Text Books:
Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. analyze the signals in both time and frequency domain
2. design FIR and IIR filters for signal pre-processing
3. implement and realize the filters using different structures.
4. explain the selection of DSP processor for signal processing applications.
ICPE31 - POWER ELECTRONICS

Course type: Programme Elective (PE)  Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To introduce the students about the theory and applications of power electronic systems for high efficiency, renewable and energy saving conversion systems.
2. To impart knowledge on the characteristics of different power electronics switches, drivers and selection of components for different applications.
3. To teach about the switching behavior and design of the converter and inverter circuits.

Course Content:

Power semiconductor switches: SCRs - series and parallel connections, driver circuits, turn-on characteristics, turn off characteristics.

AC to DC converters: Natural commutation, single phase and three phase bridge rectifiers, semi controlled and fully controlled rectifiers, dual converters.

DC to DC converters: Voltage, Current, load commutation, thyristor choppers, design of commutation elements, MOSFET/IGBT choppers, AC choppers.

DC to AC converters: Thyristor inverters, McMurray-Mc Murray Bedford inverter, current source inverter, voltage control, inverters using devices other than thyristors, vector control of induction motors.

AC to AC converters: Single phase and three phase AC voltage controllers, integral cycle control, single phase cyclo-converters - effect of harmonics and Electro Magnetic Interference (EMI).

Applications in power electronics: UPS, SMPS and Drives.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course, the students will be able to,

1. work professionally in the area of power and power related fields.
2. have good understanding of the basic principles of switch mode power conversion.
3. apply knowledge of mathematics and engineering, and identify formulas to solve power and power electronics engineering problems.
4. choose appropriate power converter topologies and design suitable power stage and feedback controllers for various applications like microprocessor power supplies, renewable energy systems and control of motor drives.
ICPE32 REAL-TIME EMBEDDED SYSTEMS

Course type: Programme Elective (PE)  Pre-requisites: ICPC20
No. of Credits: 3

Course Objectives:

1. To introduce the basic concepts of Embedded Systems
2. To expose to the design principles of advanced level ARM processors.
3. To provide basic understanding of the concepts of OS and RTOS.

Course Content:


TIVA ARM Cortex Architecture, Programming: Internal blocks – Processor core features, system peripherals, Memory map, bus system, debug support, User Peripherals, Serial Interfaces, Programming the peripherals using C – examples. Case studies of hardware design and software development.

OS Concepts and types, tasks & task states, process, threads, inter process communication, task synchronization, semaphores, role of OS in real time systems, scheduling, resource allocation, interrupt handling, other issues of RTOS. Examples of RTOS. Working with TI-RTOS with TIVA ARM Cortex embedded controllers

Text Books:


Reference Books:

2. TIVA ARM Cortex M4F Datasheets

Course Outcomes:

On completion of this course, the students will be able to,

1. design embedded system for simple applications.
2. write application programs in embedded C and test the programs using CCS.
3. develop application programs for execution under TI-RTOS environment.
ICPE33 - SMART AND WIRELESS INSTRUMENTATION

Course type: Programme Elective (PE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To expose to the basics of sensors used in industries.
2. To provide adequate knowledge on smart instrumentation and wireless sensor networks.
3. To impart knowledge on various standard protocols used in wireless instrumentation.

Course Content:

Sensor Classification - Thermal sensors-Humidity sensors-Capacitive Sensors-Planar Inter digital Sensors-Planar Electromagnetic Sensors-Light Sensing Technology-Moisture Sensing Technology-Carbon Dioxide (CO₂) sensing technology-Sensors Parameters


Tedes IEEE 1412- Brief description of API mode data transmission-Testing the communication between coordinator and remote XBee- Design and development of graphical user interface for receiving sensor data using C++; A brief review of signal processing techniques for structural health monitoring.

WSN based physiological parameters monitoring system- Intelligent sensing system for emotion recognition-WSN based smart power monitoring system. Digital light processor (DLP)

Text Books:


Reference Books:

Course Outcomes:

On completion of this course, the students will be able to,

1. design self-diagnosing instrumentation system.
2. identify the issues in power efficient systems.
3. design wireless instrumentation systems for the given requirement.
ICPE34 - DIGITAL IMAGE PROCESSING

Course type: Programme Elective (PE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To introduce the fundamentals of image processing.
2. To introduce to the various image processing techniques.
3. To impart knowledge on the design and realization of various image processing applications.

Course Content:

Introduction and Digital Image Fundamentals:
Introduction to image processing, origin, examples of fields, steps in image processing, components of image processing system, digital image fundamentals — elements of visual perception, light and electromagnetic spectrum, image sensing and acquisition, mathematical tools used in image processing.

Intensity Transformations, Spatial Filtering and Filtering in frequency domain:
Basics intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing and sharpening spatial filtering, combinations of image enhancement method, filtering in the frequency domain – Fourier transform of sample functions, DFT of one variable, extension to two variables, properties of 2 D DFTs, selective filtering, realization of FDT, FFT, filter design aspects.

Image Restoration and Reconstruction:
Model of the image degradation / restoration process, noise models, restoration in the presence of noise only – spatial filtering, periodic noise reduction by frequency domain filtering, estimating the degradation functions, inverse filtering, image reconstruction from projections.

Image Segmentation:
Image segmentation - point, line and edge detection, Thresholding, Regions Based segmentation, segmentation using morphological watersheds, usage of motion in segmentation, edge linking and boundary detection, Hough transform, chain codes, boundary segments, skeletons, boundary descriptors, Fourier descriptors.

Image Compression:
Image compression - image compression - data redundancies elements of information, variable-length coding, predictive coding, transform coding, image compression standards, wavelets and multi-resolution processing - image pyramids, sub-band coding.

Object Recognition and Case studies:
Object Recognition- patterns and pattern classes, recognition based on decision – theoretic methods, structural methods, case studies – image analysis.
Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. apply knowledge of mathematics for image understanding and analysis.
2. design, realize and troubleshoot various algorithms for image processing case studies.
3. select the appropriate hardware and software tools (Contemporary) for image analysis.
ICPE35 - MULTISENSOR DATA FUSION

Course type: Programme Elective (PE)  
Pre-requisites: ICPC24
No. of Credits: 3

Course Objectives:

1. To expose the students to the concepts and techniques used in sensor data fusion.
2. To impart skills needed to develop and apply data fusion algorithms.
3. To expose the students, the state of the art in multi sensor/source integration, target tracking and identification.

Course Content:


Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration.


High performance data structures: Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course, the students will be able to,

1. identify and characterise the principle components of data fusion and information systems.
2. apply the concepts of data fusion in sensing.
3. select fusion techniques appropriate to system and mission needs.
ICPE36 – MEDICAL IMAGING SYSTEMS

Course type: Programme Elective (PE)  
Pre-requisites: ICPE34  
No. of Credits: 3

Course Objectives:

1. To introduce the methods of medical imaging.
2. To impart knowledge in the physics behind the various imaging techniques.
3. To teach the construction and working of various imaging techniques.

Course Content:

Introduction to image processing in medical applications, X-Ray tubes, cooling systems, removal of scatters, Fluoroscopy- construction of image Intensifier tubes, angiographic setup, mammography, digital radiology, DSA.

Need for sectional images, Principles of sectional scanning, CT detectors, Methods of reconstruction, Iterative, Back projection, convolution and Back-Projection. Artifacts, Principle of 3D imaging

Alpha, Beta and Gamma radiation, Radiation detectors, Radio isotopic imaging equipments, Radio nuclides for imaging, Gamma ray camera, scanners, Positron Emission tomography, SPECT, PET/CT.

Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Imaging Modes, Principles and theory of image generation.

NMR, Principles of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition, MRI Instrumentation, Functional MRI.

Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. acquire basic domain knowledge about the various medical imaging techniques.
2. understand the construction and working of various medical imaging equipments.
3. analyze the medical images for diagnosis.
ICPE37 - INDUSTRIAL DATA COMMUNICATION

Course type: Programme Elective (PE)  
No. of Credits: 3

Pre-requisites: -

Course Objectives:

This course gives an overview to real-time communication between systems in industries and to adopt suitable protocol thereby prepare the students to take up challenges in industrial environment.

1. To expose the students to communication systems emerging in the field of instrumentation.
2. To introduce to the system interconnection and protocols.
3. To give an overview of data communication standards.

Course Content:


Fieldbus: Use of fieldbuses in industrial plants, functions, international standards, performance, use of Ethernet networks, fieldbus advantages and disadvantages. Fieldbus design, installation, economics and documentation.


PROFIBUS-PA: Basics, architecture, model, network design and system configuration. Designing PROFIBUS-PA and Foundation Fieldbus segments: general considerations, network design.

Text Books:


Reference Books:


Course Outcomes:

On the completion of this course, the students will be able to,

1. explain the rationale behind the technological development of industrial networks.
2. understand various industrial network communication protocols.
3. evaluate and select protocol for particular application.
ICPE38 - ENERGY HARVESTING TECHNIQUES

Course Type: Programme Elective (PE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To introduce basic energy harvesting techniques using smart materials and structures and combining with mechanisms.
2. To impart knowledge in the design of power converter circuits for ambient energy harvesters.
3. To introduce mathematical modelling of piezoelectric based energy harvesters.
4. To introduce on certain case studies.

Course Content:


Vibrational energy harvesting- Electromechanical Modelling of Cantilevered Piezoelectric Energy Harvester For Persistent Base Motion-lumped parameter model, correction factors, coupled distributed parameter model, modelling assumptions, closed form solution for unimorph and bimorph configuration, harvesting techniques for broadband excitation

Piezoelectric energy harvesting circuits-low power rectifier circuits with resistive, linear and nonlinear reactive input impedance, piezoelectric pre biasing, self-tuning, DC-DC switch mode converters, impedance matching circuits for maximum output power.

Electromagnetic energy harvesting- Wire wound coil properties, micro fabricated coils, magnetic materials, scaling of electromagnetic vibration generators and damping, maximizing power from an EM generator, micro and macro scale implementation.


Case study- harvester driven by muscle power, knee joint movement harvesting, etc. strategies to improve energy conversion efficiency for different ambient sources.

Text Books:

Reference Books:


Course Outcomes:

On the completion of this course, the students will be able to,

1. comprehend in the concept of various ambient energy harvesting techniques.
2. design optimal power converting circuits for different harvesters.
3. design vibration energy harvester for narrow and wide band excitation.
4. design electromagnetic and thermoelectric based energy harvesters.
5. apply the energy harvesting concepts to common engineering problems.
ICPE39 – SMART MATERIALS AND SYSTEMS

Course type: Programme Elective (PE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To familiarize the students with the different smart materials and their characteristics.
2. To expose the students to understand the functionalities through the mathematical equations.
3. To teach the students about the significant features of smart materials in sensing, actuation and control.
4. To teach the students to design and develop smart structures using smart material based actuators and sensors.

Course Content:


Actuators and Sensor based on Piezoelectric Materials: Induced Strain actuation model, Unimorph and Bimorph Actuators, Actuators embedded in composite laminate, Impedance matching in actuator design, Feedback Control, Pulse Drive, Resonance Drive, Piezoelectric as a Sensor and its applications.


Text Books:


Reference Material:

1. www.iop.org/sms

Course Outcomes:

On the completion of this course, the students will be able to,

1. acquire knowledge about the smart materials, their characteristics and design aspects.
2. design, model and control smart materials based structures/systems, through simulation and experimentation.
3. analyze and design techniques, to offer solutions to industrial problems using smart materials.
ICPE40 - HYDRAULICS AND PNEUMATICS

Course type: Programme Elective (PE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To provide an understanding of the working of hydraulic and pneumatic systems.
2. To provide an understanding of energy transfer in hydraulic actuators and motors.
3. To provide knowledge about controlling components of hydraulic and pneumatic systems.
4. To provide knowledge of design of hydraulic and pneumatic systems and analyze them.

Course Content:


Introduction to Pneumatic Control: Choice of working medium, characteristics of compressed air. Structure of pneumatic control system. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, filters, regulators, lubricators, distribution of compressed air. Pneumatic Actuators: Linear cylinders – types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications.

Text Books:


Reference Books:


Course Outcomes:

On the completion of this course, the students will be able to,

1. acquire knowledge about working of hydraulic and pneumatic systems.
2. identify the controlling components of hydraulic and pneumatic systems.
3. select and prepare a distribution system for compressed air.
4. compile the design of hydraulic and pneumatic systems and analyze them.
5. demonstrate the need of pressure and time dependent controls.
ICPE41 – INTERNET OF THINGS SYSTEM DESIGN

Course type: Programme Elective (PE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To provide a good understanding of Internet of Things (IoT) and it's envisioned deployment domains.
2. To provide an understanding of smart sensors/actuators with their internet connectivity for experimentation and designing systems.
3. To provide a overview about the various protocol standards deployed in the Internet of Things (IoT) domain and to make informed choices.
4. To impart knowledge in the design and development of IoT systems with enablement ensuring security and assimilated privacy.

Course Content:

Introduction to Internet of Things: Overview of Internet of Things- the Edge, Cloud and the Application Development, Anatomy of the Thing, Industrial Internet of Things (IIoT - Industry 4.0), Quality Assurance, Predictive Maintenance, Real Time Diagnostics, Design and Development for IoT, Understanding System Design for IoT, Design Model for IoT.


System Design Perspective for IoT – Products vs Services, Value Propositions for IoT, Services in IoT, Design views of Good Products, Understanding Context, IoT Specific Challenges and Opportunities.


Text Books:


Reference Books:

1. The Internet of Things – Opportunities and Challenges
2. Single Chip Controller and WiFi SOC
3. Wireless Connectivity Solutions
4. Wireless Connectivity for the Internet of Things – One size does not fit all

Course Outcomes:

On the completion of this course, the students will be able to,

1. understand the design architecture of IoT.
2. make choice of protocols and deployment in solutions.
3. comprehend the design perspective of IoT based products/services.
ICPE42 – SOFTWARE DESIGN TOOLS FOR SENSING AND CONTROL

Course type: Programme Elective (PE)  
Pre-requisites: ICPC11, ICPC21

No. of Credits: 3

Course Objectives:

1. To expose the students to the software tools available for sensor and control system design.
2. To teach the analytical and numerical modelling of various sensors in macro, meso and micro scale and to study its characteristics through simulation.
3. To expose the students to modelling of physical systems, design and evaluation of various control methods.
4. To expose the students to real time control implementation platforms and to practice on implementation of simple controllers.

Course Content:

Software tools for sensor design: Introduction to history of sensor design software tools, importance and need of software tools. Recent developments in sensor design and analysis software tools. Introduction to COMSOL Multiphysics, Structural Mechanics: Analysis of mechanical structures to static or dynamic loads. Stationary, transient, eigenmode/modal, parametric, quasi-static and frequency-response analysis. Electrical: AC/DC Module for simulating electric, magnetic, and electromagnetic fields in static and low-frequency applications. Design and simulation of sensors and actuators using COMSOL.


Software tools for control design: Introduction to MATLAB, Simulink and Scilab. Introduction to toolboxes. Control design problems using classical control. Control design problems using state space approach.

Implementation of controllers in real time: Introduction to various hardware platforms, control design and implementation for electrical/mechanical/electromechanical/chemical processes using dSPACE, LabVIEW and OPAL-RT.

Text Books:


Reference Books:


Course Outcomes:

On the completion of this course, the students will be able to,

1. select an appropriate software tools for sensor and actuator design.
2. design, model and simulate various sensing and actuating mechanisms.
3. design controller and evaluate its performance through simulation.
4. design a controller using state space method and evaluate its performance through simulation.
5. acquire knowledge in the selection and usage of hardware for real time implementation of controllers.
ICPE43 - INDUSTRIAL ELECTRIC DRIVES

Course type: Programme Elective (PE)  Pre-requisites: ICPE31
No. of Credits: 3

Course Objectives:

1. To introduce to the students on the concept of employing power convertors for the design of electric drives.
2. To impart knowledge on the analysis of electric drive system dynamics.
3. To impart knowledge on the design and development of control methods for electric drive systems.

Course Content:

Electric Drive System - Dynamics and steady state stability

Components of electrical Drives – electric machines, power converter, controllers - dynamics of electric drive - torque equation - equivalent values of drive parameters - components of load torques types of load - four quadrant operation of a motor — steady state stability – load equalization – classes of motor duty- determination of motor rating


Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. design suitable power electronic circuit for an electric drive system and analyse its steady state stability.
2. select appropriate control method for the electric drives.
3. select a suitable electric drive for a particular industrial application.
ICPE44 – PIPING AND INSTRUMENTATION DIAGRAMS

Course type: Programme Elective (PE)  
Pre-requisites: ICPE18  
No. of Credits: 3

Course Objectives:
1. To introduce various flow sheet design using process flow diagram.
2. To impart knowledge on P&I D symbols for pumps, compressors and process vessels.
3. To teach the line diagram symbols, logic gates of instruments.

Course Content:
Flow sheet design: Types of flow sheets, flow sheet presentation, flow sheet symbols, line symbols and designation, process flow diagram, synthesis of steady state flowsheet, flowsheeting software.

Piping and instrumentation diagram evaluation and preparation: P & I D Symbols, line numbering, line schedule, P&I D development, various stages of P&I D, P&I D for pumps, compressors process vessels, absorber, evaporator.

Control systems and interlocks for process operation: Introduction and description, need of interlock, types of interlocks, interlock for pumps, compressor, heater-control system for heater, distillation column, expander

Instrument line diagram: Line diagram symbols, logic gates, representation of line diagram.

Application of P&ID’S: Applications of P& ID in design state, construction stage, commissioning state, operating stage, revamping state, applications of P&ID in HAZAMPS and risk analysis

Text Books:

Reference Books:

Course Outcomes:
On completion of this course, the students will be able to,
1. understand of P&I diagrams standards involved and its preparation.
2. select different fittings for instruments installation used for the preparation of P&IDs.
3. to use software for preparation of P&IDs.
ICPE45 – ROBOTICS

Course type: Programme Elective (PE)  Pre-requisites: ICPC21, ICPC24

No. of Credits: 3

Course Objectives:

1. To introduce robotics in the fields of manufacturing, medicine, search and rescue, service, and entertainment.
2. To teach robotics as the synergistic integration of mechanics, electronics, controls, and computer science.

Course Content:

Introduction: Basic concepts, definition and origin of robotics, different types of robots, robot classification, applications, robot specifications.

Introduction to automation: Components and subsystems, basic building block of automation, manipulator arms, wrists and end-effectors. Transmission elements: Hydraulic, pneumatic and electric drives. Gears, sensors, materials, user interface, machine vision, implications for robot design, controllers.

Kinematics, dynamics and control: Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control, present industrial robot control schemes.

Robot programming: Robot programming languages and systems, levels of programming robots, problems peculiar to robot programming, control of industrial robots using PLCs.

Automation and robots: Case studies, multiple robots, machine interface, robots in manufacturing and non-manufacturing applications, robot cell design, selection of a robot.

Text Books:


Reference Books:

Course Outcomes:
On completion of this course, the students will,

1. learn the mathematics of rigid motions, rotations, translations, velocity kinematics.
2. be introduced to the most popular methods for motion planning and obstacle avoidance.
3. understand robot dynamics and multivariable control.
4. be familiar with computer vision, visual servo control problems and applications in the industry.
Open Elective (OE) Courses
ICOE10 - BUILDING AUTOMATION

Course type: Open Elective (OE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To introduce the basic blocks of Building Management System.
2. To impart knowledge in the design of various sub systems (or modular system) of building automation.

Course Content:

Introduction:
Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

HVAC system:
Different components of HVAC system like heating, cooling system, chillers, AHUs, compressors and filter units and their types. Design issues in consideration with respect to efficiency and economics, concept of district cooling and heating.

Access control & security systems:
Concept of automation in access control system for safety, Physical security system with components, Access control components, Computer system access control – DAC, MAC, and RBAC.

Fire & alarm system:
Different fire sensors, smoke detectors and their types, CO and CO₂ sensors, Fire control panels, design considerations for the FA system concept of IP enabled fire & alarm system, design aspects and components of PA system.

CCTV system & energy management system:
Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system, concept of energy management system, occupancy sensors, fans & lighting controller. Introduction to structural health monitoring and methods employed.

Text Books:

Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. understand the concept behind building automation.
2. plan for building automation.
3. design sub systems for building automation and integrate those systems.
ICOE11 – PROJECT ENGINEERING AND MANAGEMENT

Course Type: Open Elective (OE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To introduce students the concept of project engineering and management.
2. To make students understand the flow of engineering project and related documentation.
3. To create awareness on management and financial functions and usage of relevant tools.

Course Content:

Introduction to project management
Definition of project purpose - Scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations, inter-department and inter organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc.

Project management functions
Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. project planning and scheduling, life project engineering and management cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle.

Project cost and estimation
Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software’s used in project management.

Text Books:

Reference Books:

Course Outcomes:

On completion of this course, the students will be able to,

1. understand the different types of projects and its management.
2. understand project management and the financial tools.
3. design different documents and apply relevant tools.
ICOE12 - MEDICAL INSTRUMENTATION

Course Type: Open Elective (OE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

The course gives an introduction to the human physiological system with respect to medical instrumentation and its design and the instrumentation for measuring and analyzing the physiological parameters.

1. To educate the students on the different medical instruments.
2. To familiarise the students with the analysis and design of instruments to measure bio signals like ECG, EEG, EMG, etc.
3. To introduce about the applications of biomedical instrumentation.

Course Content:

Electro physiology: Review of physiology and anatomy, resting potential, action potential, bioelectric potentials, cardiovascular dynamics, electrode theory, bipolar and uni-polar electrodes, surface electrodes, physiological transducers. Systems approach to biological systems.

Bioelectric potential and cardiovascular measurements: Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques. Heart sound measurement - stethoscope, phonocardiograph. EMG - Evoked potential response, EEG, foetal monitor. ECG, phonocardiography, vector cardiograph, impedance cardiology, cardiac arrhythmia's, pace makers, defibrillators.

Respirator and pulmonary measurements and rehabilitation: Physiology of respiratory system, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotherapy, diathermy, nerve stimulator, Heart lung machine, Haemodialysis, ventilators, incubators, drug delivery devices, therapeutic applications of the laser.

Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems, patient monitoring through telemedicine, implanted transmitters, telemetering multiple information. Sources of electrical hazards and safety techniques.

Medical imaging systems: X ray machine, Computer tomography, ultrasonic imaging system, magnetic resonance imaging system, thermal imaging system, positron emission tomography.

Text Books:

Reference Books:


Course Outcomes:

On completion of this course the students will be,

1. able to understand, design and evaluate systems and devices that can measure, test and/or acquire biological information from the human body.
2. familiar with patient monitoring equipment used in hospitals and in telemedicine.
3. familiar with various imaging techniques used for diagnosis.
ICOE13 - MICRO ELECTRO MECHANICAL SYSTEMS

Course Type: Open Elective (OE)  
Pre-requisites:  
No. of Credits: 3

Course Objectives:

1. To introduce the concepts of microelectromechanical devices.  
2. To introduce the state-of-art micromachining techniques including surface micromachining, bulk micromachining, and related methods.  
3. To provide knowledge in the design concepts of micro sensors and micro actuators.  
4. To provide knowledge about computer aided design tools for modeling MEMS device.

Course Content:

Introduction, emergence, MEMS application, scaling issues, materials for MEMS, Thin film deposition, lithography and etching.

Bulk micro machining, surface micro machining and LIGA process.


Theory and design: Micro Pressure Sensor, micro accelerometer – capacitive and piezoresistive, micro actuator.

Electronic interfaces, design, simulation and layout of MEMS devices using CAD tools.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course the students will be able to,

1. understand the fundamental principles behind the working of micro devices/ systems and their applications.
2. gain a fundamental understanding of standard micro fabrication techniques.
3. apply knowledge of microfabrication techniques to design a MEMS device or a microsystem.
4. acquire skills in Computer aided design tools for modeling and simulating MEMS device.
ICOE14 - MEASUREMENT AND CONTROL

**Course Type:** Open Elective (OE)  
**No. of Credits:** 3  
**Pre-requisites:** -

**Course Objectives:**

1. To impart knowledge in the basics of measurement system.
2. To expose the students to various measurement techniques used for the measurement of important process variables.
3. To expose the students to the basics of control systems.

**Course Content:**

Fundamental & Importance of Instrumentation, types of instruments, selection of instruments, performance of instruments, error in measurement, calibration & standard, Calibration of instruments: Methods & analysis, Introduction to Transducer & types, Process Instrumentation, recording instruments, indicating & recording Instruments.

Strain and Displacement Measurement:  
Factors affecting strain measurements, Types of strain gauges, theory of operation, strain gauge materials, gauging techniques and other factors, strain gauge circuits and applications of strain gauges.  
Resistive potentiometer (Linear, circular and helical), L.V.D.T., R.V.D.T. and their characteristics, variable inductance and capacitance transducers, Piezo electrical transducers, Hall Effect devices and Proximity sensors.

Pressure and Temperature Measurement:  
Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement, Variable inductance and capacitance transducers, Piezo electric transducers, L.V.D.T. for measurement of pressure.  
Resistance type temperature sensors – RTD & Thermistor, Thermocouples & Thermopiles, Laws of thermocouple, Fabrication of industrial thermocouples, Radiation methods of temperature measurement.

Flow and Level Measurement:  
Differential pressure meters like Orifice plate, Venturi tube, flow nozzle, Pitot tube, Rotameter, Turbine flow meter, Electromagnetic flow meter, Ultrasonic flow meter.  
Resistive, inductive and capacitive techniques for level measurement, Ultrasonic methods, Air purge system (Bubbler method).

Elements of control systems, concept of open loop and closed loop systems, Examples and application of open loop and closed loop systems, brief idea of multivariable control systems. Brief idea of proportional, derivative and integral controllers.
Text Books:


Reference Books:


Course Outcomes:

On completion of this course the students will be,

1. familiar with the basics of measurement system, its characteristics and principles of few transducers.
2. familiar with the different temperature, pressure, flow and level measurement techniques used in process industries.
3. able to select and make measurements of temperature, flow, pressure and level in any process industry.
4. familiar with the concept of closed loop control system.
ICOE15 - INDUSTRIAL MEASUREMENTS

Course Type: Open Elective (OE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To expose the students to the importance of process variable measurements.
2. To expose the students to various measurement techniques used for the measurement of temperature, flow, pressure and level in process industries.
3. To make the students knowledgeable in the design, installation and trouble shooting of process instruments.

Course Content:

Temperature measurement: Introduction to temperature measurements, Thermocouple, Resistance Temperature Detector, Thermistor and its measuring circuits, Radiation pyrometers and thermal imaging.

Pressure measurement: Introduction, definition and units, Mechanical, Electro-mechanical pressure measuring instruments. Low pressure measurement, Transmitter definition types, I/P and P/I Converters.

Level measurement: Introduction, Mechanical and electrical methods of level measurement.


Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be,

1. familiar with the different temperature, pressure, flow and level measurement techniques used in process industries.
2. able to select and make measurements of temperature, flow, pressure and level in any process industry.
3. able to identify or choose temperature, flow, pressure and level measuring device for specific process.
ICOE16 – VIRTUAL INSTRUMENT DESIGN

Course Type: Open Elective (OE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To introduce to the students about the interfacing techniques of various transducers.
2. To expose the students to different signal conditioning circuits.
3. To impart knowledge on the hardware required to build Virtual Instrument.
4. To impart knowledge to build GUI for Virtual Instrument.

Course Content:


Data Acquisition and Hardware Selection: Overview of DAQ architecture – Analog IO & Digital IO - Finite and continuous buffered acquisition – Data acquisition with C language - Industrial Communication buses – Wireless network standards - Micro-controller selection parameters for a virtual instrument – CPU, code space (ROM), data space (RAM) requirements.


Text Books:


Reference Books:


Course Outcomes:

On completion of this course the students will be able to,

1. interface the target transducer to the signal conditioning board.
2. condition the acquired signal from the transducer to standard data formats.
3. select the most appropriate hardware for the virtual instrument to be built.
4. implement the real-time OS for the selected micro-controller and the GUI interface for the virtual instrument.
**ICOE17 - NEURAL NETWORKS AND FUZZY LOGIC**

**Course Type:** Open Elective (OE)  
**No. of Credits:** 3  
**Pre-requisites:** -

**Course Objectives:**

1. To provide an overview of intelligent techniques.
2. To introduce different architectures and algorithms of Neural Networks.
3. To impart knowledge on Fuzzy set theory and Fuzzy rules.

**Course Content:**

Introduction to fuzzy logic and neural networks, Classification, Merits and demerits of intelligent techniques compared to conventional techniques. Need of an intelligent techniques for real world Engineering applications.


Neural networks for control systems: Schemes of Neuro-control, identification and control of dynamical systems, case studies.

Fuzzy set and operations, Fuzzy relations, Fuzzifications, Fuzzy rule based systems, defuzzification fuzzy learning algorithms.

Fuzzy logic for control system with case studies. Introduction to neuro-fuzzy system and genetic algorithm.

**Text Books:**


**Reference Books:**

Course Outcomes:

On completion of this course, the students will be,

1. familiar with the basic concepts of Neural Network and Fuzzy logic.
2. able to develop Neural Network based modelling and control for different process applications.
3. able to design Fuzzy logic based control system for process applications.
ICOE18 - NETWORK CONTROL SYSTEMS

**Course Type:** Open Elective (OE)  
**Pre-requisites:** -  
**No. of Credits:** 3

**Course Objectives:**

1. To impart knowledge in different network models.
2. To introduce different network control system techniques.
3. To introduce different applications suited for network control systems.

**Course Content:**


Decentralized Control - limited computational, communications, and controls resources in networked control systems.

Multi-Agent Robotics - formation control, sensor and actuation models.

Mobile Sensor Networks - coverage control, voronoi-based cooperation strategies.

Mobile communications networks, connectivity maintenance.

**Text Books:**


**Reference Books:**


**Course Outcomes:**

On completion of this course, the students will be able to,

1. design control system in the presence of quantization, network delay or packet loss.
2. understand distributed estimation and control suited for network control system.
3. develop simple application suited for network control systems.
ICOE19 – CONTROL SYSTEMS

Course Type: Open Elective (OE)  
No. of Credits: 3

Pre-requisites: -

Course Objectives:

1. To introduce the concept of feedback control system.
2. To impart knowledge in mathematical modeling of physical systems.
3. To impart knowledge in characteristics and performance of feedback control system.
4. To teach a variety of classical methods and techniques for analysis and design of control systems.

Course Content:


Frequency Response Methods, Nyquist’s Stability Criterion, Bode Plots, Performance Specifications in Frequency-Domain, Stability Margins.

Design of Lag and PID controllers in Frequency Domain, Design of Lag-Lead Controllers using time-domain and frequency-domain methods.

Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be able to

1. generate mathematical models of dynamic control system by applying differential equations.
2. analyze and characterize the behavior of a control system in terms of different system and performance parameters.
3. compute and assess system stability.
4. evaluate and analyses system performance using frequency and transient response analysis.
5. design and simulate control systems (linear feedback control systems, PID controller, and multivariable control systems), using control software, to achieve required stability, performance and robustness.
6. critically analyses and outline the dynamic response of closed loop systems.
ICOE20 - ENERGY HARVESTING TECHNIQUES

Course Type: Open Elective (OE)  
No. of Credits: 3  
Pre-requisites: -

Course Objectives:

1. To introduce basic energy harvesting techniques using smart materials and structures and combining with mechanisms.
2. To impart knowledge in the design of power converter circuits for ambient energy harvesters.
3. To introduce mathematical modelling of piezoelectric based energy harvesters.
4. To introduce on certain case studies.

Course Content:


Vibrational energy harvesting- Electromechanical Modelling Of Cantilevered Piezoelectric Energy Harvester For Persistent Base Motion-lumped parameter model, correction factors, coupled distributed parameter model, modelling assumptions, closed form solution for unimorph and bimorph configuration, harvesting techniques for broadband excitation

Piezoelectric energy harvesting circuits-low power rectifier, circuits with resistive, linear and nonlinear reactive input impedance, piezoelectric pre biasing, self-tuning, DC-DC switch mode converters, impedance matching circuits for maximum output power.

Electromagnetic energy harvesting- Wire wound coil properties, micro fabricated coils, magnetic materials, scaling of electromagnetic vibration generators and damping, maximizing power from an EM generator, micro and macro scale implementation.


Case study- harvester driven by muscle power, knee joint movement harvesting, etc. strategies to improve energy conversion efficiency for different ambient sources.

Text Books:

Reference Books:


Course Outcomes:

On the completion of this course, the students will be able to,

1. comprehend in the concept of various ambient energy harvesting techniques.
2. design optimal power converting circuits for different harvesters.
3. design vibration energy harvester for narrow and wide band excitation.
4. design electromagnetic and thermoelectric based energy harvesters.
5. apply the energy harvesting concepts to common engineering problems.
ICOE21 – INTERNET OF THINGS

Course Type: Open Elective (OE)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To provide a good understanding of Internet of Things (IoT) and it’s envisioned deployment domains.
2. To provide an understanding of smart sensors/actuators with their internet connectivity for experimentation and designing systems.
3. To provide a overview about the various protocol standards deployed in the Internet of Things (IoT) domain and to make informed choices.
4. To impart knowledge in the design and development of IoT systems with enablement ensuring security and assimilated privacy.

Course Content:

Introduction to Internet of Things: Overview of Internet of Things- the Edge, Cloud and the Application Development, Anatomy of the Thing, Industrial Internet of Things (IIoT - Industry 4.0), Quality Assurance, Predictive Maintenance, Real Time Diagnostics, Design and Development for IoT, Understanding System Design for IoT, Design Model for IoT.


System Design Perspective for IoT – Products vs Services, Value Propositions for IoT, Services In IoT, Design views of Good Products, Understanding Context, IoT Specific Challenges and Opportunities


Domain specific IoT and their challenges: Illustrated domains-home automation, smart cities, environment, energy, retail, logistics, health and life style.
Case Study of Rapid Internet Connectivity with Cloud Service Providers with CC3200 Controller.
Text Books:


Reference Books:

1. The Internet of Things – Opportunities and Challenges
2. Single Chip Controller and WiFi SOC
4. Wireless Connectivity Solutions
6. Wireless Connectivity for the Internet of Things – One size does not fit all

Course Outcomes:

On the completion of this course, the students will be able to,

1. understand the design architecture of IoT.
2. make choice of protocols and deployment in solutions.
3. comprehend the design perspective of IoT based products/services.
**ICOE22 – INTELLECTUAL PROPERTY RIGHTS**

**Course Type:** Open Elective (OE)  
**No. of Credits:** 3  
**Pre-requisites:** -

**Course Objectives:**

1. To introduce the students about the need to be aware of IPR and the knowledge on IPR.
2. To make the students understand how IPR contributes to the economic development of the society and in turn to the nation.
3. To teach that IP is a law, economics, technology and business.
4. To make students realize how IPR protection provides an incentive to inventors for further research work and investment in R & D.

**Course Content:**

**Introduction**

**International Scenario**
International cooperation on Intellectual Property, Procedure for grants of patents, patenting under PCT.

**Patent Rights**
Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.

**New developments in IPR**
Administration of Patent system, New developments in IPR, IPR Biological systems, Computers, Software etc., Traditional knowledge, Case studies, IPR and NIT ‘s objectives towards learning IPR.

**Trademark and patenting**
Registered and unregistered trademarks, designs, concepts, idea patenting.

**Text Books:**


**Reference Books:**


**Course Outcomes:**

On the completion of this course, the students will be,

1. familiar with and realize the importance of IPR.
2. familiar with and realize how IPR are regarded as a source of national wealth and mark of an economic leadership in the context of global market scenario.
3. able to understand how IPR contributes to the economic development of the society.
ICOE23 – SMART MATERIALS AND SYSTEMS

Course Type: Open Elective (OE)  
Pre-requisites: -  
No. of Credits: 3

Course Objectives:

1. To familiarize the students with the different smart materials and their characteristics.  
2. To expose the students to understand the functionalities through the mathematical equations.  
3. To teach the students about the significant features of smart materials in sensing, actuation and control.  
4. To teach the students to design and develop smart structures using smart material based actuators and sensors.

Course Content:

Prerequisites: Foundational knowledge from Principles of mechanics, including basic statics, dynamics, and strength of materials, machine or structure design.

Piezoelectric materials: Properties - Piezoelectricity, characteristics, applications – vibration control, health monitoring, energy harvesting.

Shape-memory materials: Properties, shape memory materials, characteristics, applications – vibration control, shape control, health monitoring.

Electro-Rheological (ER) fluids: Suspensions and ER fluids, ER phenomenon, charge migration mechanism, ER fluid actuators, applications of ER fluids.

Magneto-Rheological (MR) fluids: Composition of MR fluid, applications of MR fluids.

Other smart materials and their applications: Magnetostrictive materials, Electrostrictive materials, Magnetic Shape Memory Alloy, Composites, Ionic Polymer Metal Composites. Bio inspired engineering and micro electro mechanical systems using smart materials.

Text Books:

Reference Material:

1. www.iop.org/sms

Course Outcomes:

On completion of this course, the students will be able to,

1. acquire knowledge about the smart materials, their characteristics and design aspects.
2. design, model and control smart materials based structures/systems, through simulation and experimentation.
3. analyze and design techniques, to offer solutions to industrial problems using smart materials.
Courses for B. Tech Minor (MI) Programme
ICMI10 – TRANSDUCER ENGINEERING

**Course Type:** Minor (MI)  
**No. of Credits:** 3  
**Pre-requisites:** -

**Course Objectives:**

1. To expose the students to various sensors and transducers for measuring mechanical quantities.
2. To make the students familiar with the specifications of sensors and transducers.
3. To teach the basic conditioning circuits for various sensors and transducers.
4. To introduce advances in sensor technology.

**Course Content:**

General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data.

Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: Load and torque measurement, Digital displacement transducer.

Self and mutual inductive transducers- capacitive transducers, eddy current transducers, proximity sensors, tacho-generators and stroboscope.


Introduction to semiconductor sensor, materials, scaling issues and basics of micro fabrication. Smart sensors.

**Text Books:**


**Reference Books:**

Course Outcomes:

On completion of this course, the students will be,

1. familiar with the basics of measurement system and its input, output configuration.
2. familiar with both static and dynamic characteristics of measurement system.
3. familiar with the principle and working of various sensors and transducers.
4. able to design signal conditioning circuit for various transducers.
5. able to select proper transducer / sensor for a specific measurement application.
ICMI11 – TEST AND MEASURING INSTRUMENTS

Course Type: Minor (MI)  Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To give an overview of current, voltage and power measuring electrical, electronics and
digital instruments.
2. To expose the students to the design of bridges for the measurement of resistance,
capacitance and inductance.
3. To give an overview of test and measuring instruments.

Course Content:

Electrical measurements: General features and Classification of electro mechanical instruments.
Principles of Moving coil, moving iron instruments. Extension of instrument range: shunt and
multipliers, CT and PT.

Measurement of Power: Electrodynamical wattmeter’s, Low Power Factor (LPF) wattmeter, errors,
calibration of wattmeter. Single and three phase power measurement, Hall effect wattmeter,
thermal type wattmeter.

Different methods of measuring low, medium and high resistances, measurement of inductance &
capacitance with the help of AC Bridges, Q Meter.

Digital Measurement of Electrical Quantities: Concept of digital measurement, block diagram Study
doing of digital voltmeter, Digital multimeter, Digital LCR meter, Digital wattmeter and energy meters.

DSO, Function generator, Audio frequency signal generation, Waveform analyzers, Spectrum
analyzers.

Text Books:

1. Golding, E.W. and Widdis, F.C., Electrical Measurements and Measuring Instruments,
2. David A. Bell, Electronic Instrumentation and Measurements, Oxford University Press, 3rd
3. Shawney A K, A course in Electrical and Electronic Measurements and Instrumentation,

Reference Books:

1. Cooper, W.D. and Helfric, A.D., Electronic Instrumentation and Measurement Techniques,
2. Kalsi.H.S, Electronic Instrumentation, Tata Mcgraw Hill Education Private Limited, 3rd
Course Outcomes:

On completion of this course, the students will be,

1. familiar with various measuring instruments (ammeters, voltmeters, wattmeters, energy meters, extension of meters, current and voltage transformers) used to measure electrical quantities.
2. able to design suitable DC and AC bridges for the measurement of R, L, C and Frequency measurement.
3. able to suggest the kind of instrument suitable for typical measurements.
4. able to use the test and measuring instruments effectively.
ICMI12 – MEASUREMENTS IN PROCESS INDUSTRIES

Course Type: Minor (MI)  
No. of Credits: 3  
Pre-requisites: -

Course Objectives:

1. To expose the students to the importance of process variable measurements.
2. To expose the students to various measurement techniques used for the measurement of temperature, flow, pressure and level in process industries.
3. To make the students knowledgeable in the design, installation and trouble shooting of process instruments.

Course Content:

Temperature measurement: Introduction to temperature measurements, Thermocouple, Resistance Temperature Detector, Thermistor and its measuring circuits, Radiation pyrometers and thermal imaging.

Pressure measurement: Introduction, definition and units, Mechanical, Electro-mechanical pressure measuring instruments. Low pressure measurement, Transmitter definition types, I/P and P/I Converters.

Level measurement: Introduction, Capacitance pickup, Ultrasonic pickup.


Hot wire anemometer and ultrasonic flow meters. Calibration and selection of Flow meters

Text Books:


Reference Books:

Course outcomes:

On completion of this course, the students will be,

1. familiar with the different temperature, pressure, flow and level measurement techniques used in process industries.
2. able to select and make measurements of temperature, flow, pressure and level in any process industry.
3. able to identify or choose temperature, flow, pressure and level measuring device for specific process.
ICMI13 – ESSENTIALS OF CONTROL ENGINEERING

Course Type: Minor (MI)  
Pre-requisites: -
No. of Credits: 3

Course Objectives:

1. To expose the students to the fundamentals of feedback control system.
2. To impart the knowledge on different types of control systems representation in pictorial and mathematical forms.
3. To teach the performance characteristics and analysis of control systems in time and frequency domain.

Course Content:

Introduction to control system – Open loop and Closed loop system – Feedback system characteristics – Block diagram reduction techniques – Signal flow graph.

Order and type of system – time domain and frequency domain response of different system characteristics using simulation software – Introduction of stability – Routh Hurwitz stability criteria.

Introduction to bode and Nyquist plot – Plotting of bode and Nyquist plot using simulation software - Gain Margin and Phase margin calculation.

Introduction to different compensator design – the design of different compensator design using simulation software.  PID controller design using simulation software.

Application of control system for different domain with case studies.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course, the students will be able to,

1. appreciate the importance of feedback control system.
2. analyze and design the system performance using time domain and frequency domain techniques.
3. use simulation software for classical control system design and analysis.
ICMI14 – INDUSTRIAL AUTOMATION AND CONTROL

Course Type: Minor (MI)  
No. of Credits: 3  
Pre-requisites: -

Course Objectives:

1. To introduce the importance of process automation techniques.
2. To impart required knowledge in PLC based programming.
3. To introduce to the students to the distributed control system and different communication protocols.

Course Content:

Introduction and overview of Industrial automation – Block diagram of PLC – different types of PLC – Type of input and output – Introduction to relay logic- Application of PLC.

Introduction to Ladder logic programming – Basic instructions – Timer and Counter instruction- Arithmetic and logical instruction – MCR, PID controller and other essential instruction sets - Case studies and examples for each instruction set.

Introduction to high level PLC language – Programming of PLC using simulation software – Real time interface and control of process rig/switches using PLC.

Introduction to DCS and SCADA - Block diagram – function of each component – Security objective – Operation and engineering station interface – Communication requirements.

Development of different control block using DCS simulation software – Real time control of test rigs using DCS. Introduction to HART, Fieldbus and PROFIBUS – Application and case studies of large scale process control using DCS.

Text Books:


Reference Books:

Course Outcomes:

On completion of this course, the students will be familiar with,

1. the process automation technologies.
2. design and development of PLC ladder programming for simple process applications.
3. the different security design approaches, engineering and operator interface issues for designing distributed control system.
4. the latest communication technologies like HART and Field bus protocol.
Essential Programme Laboratory Requirement (ELR) Courses
ICLR10 – THERMODYNAMICS AND FLUID MECHANICS LABORATORY

Course Type: Essential Laboratory Requirement (ELR)
No. of Credits: 2

Course Objectives:

1. To familiarize with the principles of thermal energy and its transformation to mechanical energy.
2. To introduce about thermodynamics - concepts and properties, first and second law.
3. To provide a working knowledge of thermodynamics and fluid mechanics.

List of Experiments:

Thermodynamics
1. Performance test on Petrol and Diesel Engines with Mechanical and Electrical Dynamometers
2. Morse test on multi-cylinder petrol engine
3. Determination of volumetric efficiency on Diesel engine and Two stage reciprocating Air compressor
4. COP in compression refrigerator cycle
5. Test on Air conditioning system
6. Viscosity index of lubricant
7. Study of steam power plant

Fluid Mechanics
1. Determination of pipe friction
2. Calibration of flow meters – Venturimeter and Orifice meter
3. Determination of discharge coefficients for notches
4. Determination of minor losses
5. Centrifugal pump
6. Submersible pump
7. Jet pump
8. Gear pump
9. Screw pump

Reference Books:

Course Outcomes:

On completion of this lab, the students will be able to,

1. understand heat, work, internal energy, and 1st and 2nd law of thermodynamics.
2. carryout dimensional analysis, fluid statics and dynamics.
3. demonstrate fluid mechanics fundamentals, including concepts of mass and momentum conservation.
4. apply the Bernoulli equation and control volume analysis to solve problems in fluid mechanics.
ICLR11 – CIRCUITS AND DIGITAL LABORATORY

Course Type: Essential Laboratory Requirement (ELR)
No. of Credits: 2

Course Objectives:

1. To introduce to the design of passive, bilateral electrical circuits.
2. To impart knowledge in network analysis and realization.
3. To impart knowledge in design and verification of combinational and sequential logic circuits.

List of Experiments:

1. Verification of Electrical Circuit laws and network theorems.
4. A.C. circuits and Network realization.
5. Design and verification of combinational logic circuits.
6. Design and verification of sequential logic circuits.

Reference Books:


Course Outcomes:

On completion of this lab, the students will be able to,

1. design and analyze electrical circuits based on circuit laws and network theorems.
2. analyze the time response and frequency response of RL, RC and RLC circuits.
3. design and verify sequential and combinational logic circuits.
ICLR12 – SENSORS AND TRANSDUCERS LABORATORY

Course Type: Essential Laboratory Requirement (ELR)
No. of Credits: 2

Course Objectives:

1. To familiarize the students to the basic principles of various transducers.
2. To impart knowledge in static and dynamic characteristics of sensors.
3. To impart knowledge in the design of signal conditioning circuits for transducers.

List of Experiments:

1. Characteristics of (Resistive and Thermo emf) temperature sensor
2. Characteristics of Piezoelectric measurement system
3. Measurement of displacement using LVDT
4. Characteristics of Hall effect sensor
5. Measurement of strain using strain gauges
6. Measurement of torque using Strain gauges
7. Measurement using proximity sensors
8. Characteristics of capacitive measurement systems
9. Loading effects of Potentiometer
10. Design of Opto-coupler using photoelectric transducers
11. Characteristics of Micro pressure and Micro accelerometer sensing device
12. Study of speed measuring devices and Gyroscope

Reference Books:


Course Outcomes:

On completion of this lab, the students will be able to,

1. analyze the static characteristics of different measurement systems.
2. design signal conditioning circuits for transducers.
3. formulate the design specification of transducer for a given application.
ICLR13 – ANALOG SIGNAL PROCESSING LABORATORY

Course type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Objectives:

1. To introduce system level design.
2. To impart knowledge in design and test Op-amp and other ICs based circuits.
3. To familiarize the students in simulation tools and evaluation boards available for analog signal processing.

List of experiments:

1. Design of amplifiers using various modes and its implementation issues
2. Filter design using various methodologies for different set of specifications
3. Sensor linearization and bridge linearization using op-amps
4. Design of waveform generators using op-amp
5. PLL design
6. Regulator design
7. Analog to digital conversion & digital to analog conversion
8. Regenerative feedback circuit design - Schmitt trigger and Multivibrator
9. Transmitter design

Text Books:


Course Outcomes:

On completion of this lab, the students will be able to,

1. design analog and digital system level circuit.
2. simulate and validate analog IC circuits using simulation software.
3. apply this basic IC circuit design concepts for application.
ICLR14 – INSTRUMENTATION LABORATORY

Course Type: Essential Laboratory Requirement (ELR)
No. of Credits: 2

Course Objectives:

1. To familiarize the students with different signal conditioning circuits for temperature and pressure measuring transducer.
2. To familiarize the students to the calibration practices used in industries.
3. To impart knowledge in the transmitter design.

List of Experiments:

1. Design of temperature transmitter using RTD.
2. Design of cold junction compensation circuit for Thermocouple.
3. Design of IC temperature transmitters.
5. Study of zero elevation and suppression in differential pressure transmitter.
6. Performance evaluation of pressure gauges using Dead weight tester.
8. Design of alarms and annunciators for process variable measurements.
9. Design of pressure/force transmitter

Reference Books:


Course Outcomes:

On completion of this lab, the students will be able to,

1. suggest a suitable temperature sensor for an application.
2. design the required conversion and manipulation circuits for temperature and pressure measurement systems.
3. evaluate various temperature and pressure measuring sensors.
ICLR15 – MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

Course Type: Essential Laboratory Requirement (ELR)
No. of Credits: 2

Course Objectives:

1. To impart knowledge in the interfacing the microprocessor with external peripherals.
2. To familiarize with ARM processor to learn how a program gets executed in a microprocessor/ microcontroller.
3. To fabricate a micro-controller circuit board using KiCAD open-source PCB design tool.
4. To teach students on programing a micro-controller using a C language based compiler.

As a part of this laboratory course, the students will have to interface microprocessor with external peripherals.
The students have to practice the ARM processor programming in the LPC2148 kit.
Students have to fabricate an 8051-based hardware board and perform the microcontroller experiments.

List of Experiments:

1. Programming exercises to programmable peripheral interface.
3. Programming exercises to use the timer.
6. Basic I/O operations and ADC Interfacing using KEIL software.
7. Counting Pulses using Interrupt and Serial Data Transmission.
8. Interfacing 8051 with DAC.
9. Interfacing 8051 with stepper motor.
10. Real time clock and memory interfacing with 8051.

Reference Books:

Course Outcomes:

On completion of this lab, the students will be able to,

1. program microprocessor/ micro-controller using a C language based compiler.
2. interface the peripherals with microprocessor and microcontrollers.
3. fabricate a micro-controller circuit board using KiCAD open-source PCB design tool.
ICLR16 – CONTROL ENGINEERING LABORATORY

Course Type: Essential Laboratory Requirement (ELR)
No. of Credits: 2

Course Objectives:

1. To impart knowledge on analysis and design of control system in time and frequency domain.
2. To impart knowledge in classical control and state space based control system design.
3. To familiarize the students with MATLAB Real-time programming to collect and process data.

List of Experiments:

1. Time response characteristics of a second order system.
2. Frequency response characteristics of a second order system.
3. Constant gain compensation in time and frequency domain.
4. Compensating Networks - Characteristics
5. Design of compensation networks - Lead, Lag, Lead-lag
6. Design of state feedback controller.
7. Observer design - full order and reduced order.

Reference Books:


Course Outcomes:

On completion of this lab, the students will be able to,

1. design control systems in both classical and modern techniques.
2. design and implement controllers to regulate and control various systems.
3. design full order and reduced order state observer.
ICLR17 – INDUSTRIAL AUTOMATION AND PROCESS CONTROL LABORATORY

Course Type: Essential Laboratory Requirement (ELR)
No. of Credits: 2

Course Objectives:

1. To impart practical knowledge in PC based data acquisition, analysis and control of different process trainers.
2. To teach the industrial automation concept and programming techniques.
3. To familiarize the process modelling and control using simulation tools.

List of Experiments:

1. Identification of FOPDT and SOPDT process using time domain and frequency domain techniques.
2. Design of different PID controller for FOPDT and SOPDT process using different standard technique and evaluate qualitative & quantitative performance.
4. Design and Verification of Combinational & Sequential Circuits Using PLC.
6. Study the effect of different PID Controller Parameters using real time process trainer.
7. Pressure to Current & Current to Pressure Convertor using real time process trainer.
8. Design of Timer and Counter Using PLC.
9. Design of PLC programming for practical applications.
10. Design of Cascade and Feed forward-feedback Controller using simulation software.
11. Verification of Control Valve Characteristics using pneumatic and electronic control value trainer.
12. Development of P&I design using Distributed control system (DCS).

Reference Books:


Course Outcomes:

On completion of this lab, the students will be able to,
1. design PID controller and tune the same for various process.
2. implement sequential logic control using PLC for a required application.
3. use the simulation tools for the design of controller for various process.
Advanced Level Courses for B. Tech (Honours)
ICHO10 – DESIGN OF SENSORS AND TRANSDUCERS

Course Type: Honours (HO)  
Pre-requisites: ICPC11  
No. of Credits: 3

Course Objectives:

1. To provide fundamentals of various types of diaphragm design.
2. To familiarize with design of strain gauge, capacitive and inductive based transducers and its applications.
3. To furnish the knowledge on design of accelerometer and gyroscope.
4. To provide the basics of various chemical sensors and its design criterion.

Course Content:

Introduction to diaphragm; Diaphragm performance and materials, Design of flat diaphragms, flat diaphragms with rigid centre – Design of convex diaphragms, semiconductor diaphragms and rectangular diaphragms – Design of corrugated diaphragms.

Design of strain gauge based load cells, torque sensors, force sensors and pressure sensors.

Design of capacitance based displacement, pressure and level sensors; Design of self and mutual inductance transducers for measurement of displacement and other parameters; Design of capacitive and inductive proximity sensors.


Introduction to chemical Sensors, characteristics. Design of direct and complex chemical sensors.

Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. select and design diaphragm for different practical applications.
2. design strain gauge based torque, force, load and pressure measurement systems.
3. design capacitance/ inductance transducers for the measurement of displacement, pressure and level.
4. acquire knowledge in design of accelerometer and gyroscope.
ICHO11 - INSTRUMENTATION SYSTEM DESIGN

Course Type: Honours (HO)  
Pre-requisites: ICPC17, ICPC22  
No. of Credits: 3

Course Learning Objectives:

1. To impart knowledge in the design of signal conditioning circuit for different process variables. 
2. To introduce about control valve sizing and section of pumps for practical applications. 
3. To familiarize with the concepts of micro controller based design for process applications.

Course Content:

Flow and Temperature:
Orifice meter - design of orifice for given flow condition - design of rotameter - design of RTD measuring circuit - design of cold junction compensation circuit for thermocouple using RTD - Transmitters – zero and span adjustment in D/P transmitters and temperature transmitters.

Pressure and Level:
Bourdon gauges - factors affecting sensitivity - design of Bourdon tube - design of Air purge system for level measurement.

Valves:
Control valves - design of actuators and positioners - types of valve bodies - valve characteristics - materials for body and trim - sizing of control valves - selection of body materials and characteristics of control valves for typical applications.

Pumps:
Types of pumps - pump performance - pipe work calculation - characteristics of different pumps - pump operation - maintenance - instruments used in pumping practice - pump noise and vibration - selection of pumps. Electronic P+I+D controllers - design - adjustment of setpoint, bias and controller settings.

Microcontroller Based Design: 
Design of logic circuits for alarm and annunciator circuits, interlocks - design of microcontroller based system for data acquisition - design of microprocessor based P+I+D controller.

Text Books:

Reference Books:


Course Outcomes:

On completion of this course, the students will be able to,

1. design temperature, flow and level measurement system for process application.
2. analyze the requirement of control system components and suggest an appropriate design procedure.
3. design microcontroller based measurement and control system.
ICHO12 - MICRO SYSTEM DESIGN

Course Type: Honours (HO)  
Pre-requisites: ICPE12  
No. of Credits: 3

Course Objectives:

1. To provide knowledge on MEMS design and various fabrication process.
2. To impart knowledge on mechanics of membranes and beams in micro scale.
3. To convey the design principles of electrostatic actuation and sensing.
4. To impart design knowledge on micro pressure sensor and micro accelerometer.
5. To provide knowledge on MEMS sensor integration and packaging.

Course Content:

Introduction, An approach to MEMS design, Basic introduction to fabrication, process integration.

Energy conserving transducer, Mechanics of membranes and beams

Electrostatic Actuation and Sensing, Effects of electrical excitation

Design of Micro pressure sensor and Micro accelerometer

Electronic Integration and Packaging

Text Books:


Reference Books:


Course Outcomes:

Upon successful completion of this course, students will be able to:

1. design and fabricate simple micro devices.
2. design and analyse simple mechanical structures used in sensor actuator.
3. design electrostatic based actuation and sensing devices, micro pressure sensor and micro accelerometer.
4. understand sensor integration and packaging techniques.
ICH013 – CONTROL SYSTEM DESIGN

Course Type: Honours (HO)  
Pre-requisites: ICPC21, ICPC24  
No. of Credits: 3

Course Objectives:

1. To impart knowledge in the concepts and techniques of linear and nonlinear control system analysis and synthesis in the modern control (state space) framework.
2. To teach the control design using the classical design principles
3. To teach the controller and observer designs

Course Content

Design of Feedback Control Systems: Introduction; Approaches to System Design; Cascade Compensation Networks; Phase-Lead Design Using the Bode Diagram; Phase-Lead Design Using the Root Locus; System Design Using Integration Networks; Phase-Lag Design Using the Root Locus; Phase-Lag Design Using the Bode Diagram; Design on the Bode Diagram Using Analytical Methods; Systems with a Pre-filter; Design for Deadbeat Response; Design Examples.

Design of State Variable Feedback Systems Introduction, State space representation of physical systems, State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc., Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, State transition matrix, Solution of state equations, Controllability and Observability, Full-State Feedback Control Design; Observer Design; Integrated Full-State Feedback and Observer; Tracking Reference Inputs; Internal Model Design; Design Examples.

Lyapunov's stability and optimal control positive/negative definite, positive/negative semi-definite functions, Lyapunov stability criteria, introduction to optimal control, Riccatti Equation, Linear Quadratic Regulator, Design Examples.

Text Books:

Reference Books:
Course Outcomes:

On completing this course, the student would be able to,

1. develop mathematical models for various physical systems.
2. design state feedback controllers and observers.
3. design nonlinear controllers using Lyapunov theory.
ICHO14 - ADVANCED PROCESS CONTROL

Course Type: Honours (HO)  Pre-requisites: ICPC21, ICPC25
No. of Credits: 3

Course Objectives:

1. To expose students to the advanced control methods used in industries and research.
2. To teach various system identification and parameter estimation techniques.
3. To prepare the student to take up such challenges in his profession.

Course Content:

Review of Single Input Single Output (SISO) Control; Model Based Control; Multivariable control strategies; Internal Model Control Preliminaries and Model Predictive Control, Model forms for Model Predictive Control, Model forms for Model Predictive Control; Parametric and Non-parametric Models, State space and Transfer Function Representations and their inter relationships; Control relevant process identification; Choice of Input Signals and Model Forms; Parameter Estimation using batch and Recursive Least Squares; Model Validations using Correlation Concepts; Identification of Non-parametric Representations; Model Predictive Control; Analysis of Dynamic Matrix Control (DMC) and Generalized Predictive Control (GPC) Schemes, Controller Tuning and Robustness Issues; Extensions to Constrained and Multivariable Cases.

Text Books:


Reference Books:


Course Outcomes:

On completion of this course, the student will be able to

1. design an appropriate advanced controller for specific problems in chemical industry.
2. suggest a controller and tune its parameters.
3. design of controllers for interacting multivariable systems.
ICH015 – OPTIMAL AND ROBUST CONTROL

Course Type: Honours (HO)  Pre-requisites: ICPC21, ICPC24
No. of Credits: 3

Course Objectives:

1. To provide a basic knowledge of the theoretical foundations of optimal control.
2. To develop the skill needed to design controllers using available optimal control Theory and software.
3. To introduce to current research in optimization methods for robust control.

Course Content:


Robust/H∞ Control: Introduction, Critique of LQG, Performance specification and robustness: Nominal performance of feedback system; Nominal performance: Multivariable case, Novel problem formulation of classical problem, Modeling uncertainty, Robust stability, Mathematical background: Singular Value Decomposition (SVD); Singular values and matrix norms; The supremum of functions, Norms and spaces, H2 Optimization and Loop Transfer Recovery (LTR), H∞ Control: A brief history, Notation and terminology, The two-port formulation of control problems; H∞ control problem formulation and assumptions; Problem solution, Weights in H∞ control problems, Design example.


Text Books:

Reference Books:


Course Outcomes:

Upon completing this course, the students would be able to,

1. design and implement system identification experiments.
2. use input-output experimental data for identification of mathematical dynamical models.
3. use singular value techniques to analyze the robustness of control systems.
4. incorporate frequency-domain-based robustness specifications into multivariable control system designs.
5. use H-infinity methods to design robust controllers.
6. explain the advantages and disadvantages of robust control relative to other control approaches.
ICH016 – ELECTRONICS FOR SENSOR DESIGN

Course Type: Honours (HO)  Pre-requisites: ICPC14, ICPC18, ICPC20
No. of Credits: 3

Course Learning Objectives:

1. To provide knowledge on the design of signal conditioning circuits for resistive and capacitive transducers to obtain improved characteristics.
2. To impart knowledge about electronic conditioning circuits for temperature measuring transducers.
3. To provide knowledge on the design of transmitters with industrial standard.
4. To impart the knowledge of data acquisition system design.
5. To provide knowledge about the use of artificial intelligence technique for enhancing sensor characteristics.

Course Content:


Review of transmitters – design of two wire and four wire transmitters using analog electronic circuits and IC’s.

Introduction to data acquisition system, issues related to interfacing of static and dynamic sensors. Design of data acquisition for a given measurement application (Theory and practical).

Introduction to Fuzzy logic and neural networks. Use of Fuzzy logic and neural networks for sensor linearization and improvement of other characteristics.

Text Books:

Reference Books:


Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Design signal conditioning circuits for resistive and capacitive transducers
2. Understand the procedure to design conditioning circuits for temperature measuring transducers.
3. Design the transmitters for sensor interface.
4. Understand the design methods of data acquisition system.
5. Use artificial intelligence techniques for improving sensor characteristics.