ANNAMALAI UNIVERSITY
DEPARTMENT OF ELECTRONICS & INSTRUMENTATION
ENGINEERING

VISION

To nurture higher echelons of technology through participative education, innovative and collaborative research with a view to bring out employable graduates of International standard.

MISSION

- To establish state of art facilities related to diverse dimension in the field of Instrumentation Engineering, Biomedical Engineering and Microelectronics and MEMS.
- To foster higher quality of education with equivocal focus in theory and practical areas of Electronics, Control and Instrumentation Engineering, Biomedical Engineering and Microelectronics and MEMS.
- To ensure that the dissemination of knowledge reaches the stakeholders and forge the opening of a fresh flair of human resources.
- To create opportunities for advancements in different facets of this discipline and offer avenues to reach the citadels of one’s carrier.

M.E. (PROCESS CONTROL AND INSTRUMENTATION)

PROGRAM EDUCATIONAL OBJECTIVES

The major objectives of the M.E (Process Control & Instrumentation) programme are to equip the students with adequate knowledge and skills in the areas of Process Control and Instrumentation and prepare them for:

1. Imparting practical knowledge in process control and design of instrumentation systems and contribute to technological development.
2. Attaining professional competency to address the technological needs of society and industrial problems.

PROGRAM OUTCOMES

A student who has undergone the M.E (Process Control & Instrumentation) program would have acquired abilities to
1. Apply knowledge of mathematics, science and engineering in practice.
2. Identify, analyse, formulate and solve engineering problems with comprehensive knowledge.
3. Handle emerging technologies relating to process industries.
4. Design process systems and provide solutions considering health, safety and environmental factors.
5. Provide innovative solutions to Industrial/Research problems.

### Mapping of PEO with PO

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ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY
M.E. / M. Tech (Two-Year Full Time & Three-year Part Time) DEGREE PROGRAMME

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS

1. Condition for Admission
Candidates for admission to the first year of the four-semester M.E / M.Tech Degree programme in Engineering shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the condition regarding qualifying marks and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The admission for part-time programme is restricted to those working or residing within a radius of 90 km from Annamalainagar. The application should be sent through their employers.

2. Branches of Study in M.E / M.Tech
The Branch and Eligibility criteria of programmes are given in Annexure 1

3. Courses of study
The courses of study and the respective syllabi for each of the M.E / M.Tech programmes offered by the different Departments of study are given separately.

4. Scheme of Examinations
The scheme of Examinations is given separately.

5. Choice Based Credit System (CBCS)
The curriculum includes three components namely Professional Core, Professional Electives and Open Electives in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.

6. Assignment of Credits for Courses
Each course is normally assigned one credit per hour of lecture / tutorial per week and one credit for two hours or part thereof for laboratory or practical per week. The total credits for the programme will be 65.

7. Duration of the programme
A student of M.E / M.Tech programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.

8. Registration for courses
A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head
of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and II shall be done at the appropriate semesters.

9. Electives
The student has to select two electives in first semester and another two electives in the second semester from the list of Professional Electives. The student has to select two electives in third semester from the list of Open Electives offered by the department/ allied department. A student may be allowed to take up the open elective courses of third semester (Full Time program) in the first and second semester, one course in each of the semesters to enable them to carry out thesis in an industry during the entire second year of study provided they should register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves for clarifications. No specific slots will be allotted in the time table for such courses.

Further, the two open elective courses to be studied in III semester (Full Time programme) may also be credited through the SWAYAM portal of UGC with the approval of Head of the Department concerned. In such a case, the courses must be credited before the end of III Semester.

10. Assessment
The break-up of continuous assessment and examination marks for theory courses is as follows:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Marks</th>
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<tr>
<td>First assessment (Mid-Semester Test-I)</td>
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<td>Second assessment (Mid-Semester Test-II)</td>
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<td>Third Assessment</td>
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<tr>
<td>End Semester Examination</td>
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The break-up of continuous assessment and examination marks for Practical courses is as follows:

<table>
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<tr>
<th>Assessment</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>First assessment (Test-I)</td>
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<tr>
<td>Second assessment (Test-II)</td>
<td>15</td>
</tr>
<tr>
<td>Maintenance of record book</td>
<td>10</td>
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<tr>
<td>End Semester Examination</td>
<td>60</td>
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</tbody>
</table>

The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

11. Student Counsellors (Mentors)
To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester,
monitor their progress in SWAYAM courses / open elective courses and obtain the final approval of the Head of the Department.

12. Class Committee
For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department.
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet three times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory / 40 marks for practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study
A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of four years for Full time / six years for Part time.

14. Substitute Assessments
A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.
A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.

15. **Attendance Requirements**

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. **Passing and declaration of Examination Results**

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

<table>
<thead>
<tr>
<th>Marks Range</th>
<th>Letter Grade</th>
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<tr>
<td>90 to 100 marks</td>
<td>Grade ‘S’</td>
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<tr>
<td>80 to 89 marks</td>
<td>Grade ‘A’</td>
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<tr>
<td>70 to 79 marks</td>
<td>Grade ‘B’</td>
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<tr>
<td>60 to 69 marks</td>
<td>Grade ‘C’</td>
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<tr>
<td>55 to 59 marks</td>
<td>Grade ‘D’</td>
</tr>
<tr>
<td>50 to 54 marks</td>
<td>Grade ‘E’</td>
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<tr>
<td>Less than 50 marks</td>
<td>Grade ‘RA’</td>
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<tr>
<td>Withdrawn from the Examination</td>
<td>Grade ‘W’</td>
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</table>

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Grade Point</th>
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<tr>
<td>S</td>
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<td>A</td>
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<td>D</td>
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<tr>
<td>E</td>
<td>5</td>
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<tr>
<td>RA</td>
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</table>

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.
After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. Awarding Degree
After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA.

For First Class with Distinction the student must earn a minimum of 65 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 65 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 65 credits within four years for full-time / six years for Part time from the time of admission.

18. Ranking Of Candidates
The candidates who are eligible to get the M.E / M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. Transitory Regulations
If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Department</th>
<th>Programme (Full Time &amp; Part time)</th>
<th>Eligible B.E./B.Tech Programme *</th>
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<td>iii. Geotechnical Engineering</td>
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<td>iv. Disaster Management &amp; Engg.</td>
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<td>ii. Welding Engineering</td>
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<td>ii. Smart Energy Systems</td>
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<td>iii. Power System</td>
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<td><strong>Electronics &amp; Instrumentation Engineering</strong></td>
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<td>i.</td>
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<td>iii.</td>
<td>Industrial Bio Technology</td>
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<td>iv.</td>
<td>Industrial Safety Engineering</td>
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<tr>
<th>10</th>
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* AMIE in the relevant discipline is considered equivalent to B.E*
## DEPARTMENT OF ELECTRONICS and INSTRUMENTATION ENGINEERING

**Curriculum for M.E.(Process Control and Instrumentation) – Full Time**

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<thead>
<tr>
<th>Sl. No.</th>
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<th>Sl. No.</th>
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**Note:** * - Four weeks during the summer vacation at the end of II\textsuperscript{nd} Semester.

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M.E. (Process Control and Instrumentation) DEGREE PROGRAMME
(PART TIME)
Choice Based Credit System(CBCS)
Courses of Study and Scheme of Examination

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| Semester – II |
| 1 | PC-IV | PPCIC 201 | Industrial Data Communication and Control | 4 | - | - | 25 | 75 | 100 | 3  |
| 2 | PC-V  | PPCIC 202 | Instrumentation System Design         | 4 | - | - | 25 | 75 | 100 | 3  |
| 3 | PC-VI | PPCIC 203 | Advanced Process Control              | 4 | - | - | 25 | 75 | 100 | 3  |
| Total | | | | 12 | - | - | 75 | 225 | 300 | 9  |

| Semester – III |
| 1 | PC-VII | PPCIC 301 | Industrial Instrumentation          | 4 | - | - | 25 | 75 | 100 | 3  |
| 2 | PE-I   | PPCIE 302 | Professional Elective – I           | 4 | - | - | 25 | 75 | 100 | 3  |
| 3 | PE-II  | PPCIE 303 | Professional Elective – II          | 4 | - | - | 25 | 75 | 100 | 3  |
| 4 | PC Lab-I | PPCIP 304 | Process Control and Instrumentation lab. | - | - | 3 | 40 | 60 | 100 | 2  |
| Total | | | | 12 | - | 3 | 115 | 285 | 400 | 11 |

Equivalent Course Code in M.E. Full Time:
- PCIC 101
- PCIC 102
- PCIC 103
- PCIC 201
- PCIC 202
- PCIC 203
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- PCIE 105
- PCIE 106
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**L:** Lecture , **P:** Practical, **T:** Thesis, **CA:** Continuous Assessment; **FE:** Final Examination
# LIST OF ELECTIVES

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COURSE OBJECTIVES

- To formalise knowledge of the theory of probability and random variables.
- To present methods of solving systems of linear equations and vector spaces.
- To cover a variety of different problems in Graph Theory.

Probability Theory:


Linear Algebra and Vector Space:

Numerical Solution of Partial Differential Equations:

Topics in Graph Theory:
Graphs – Eular paths and circuits, Hamiltonian paths and circuits – trees – undirected trees – spanning trees and minimal spanning trees.

REFERENCES
3. Hoffman and Kanz – Linear Algebra , PHT.
4. N. Deo – Graph Theory, TMH India.

COURSE OUTCOMES
Upon completing the course, the student will be able to
1. Understand the formulation of modern Probability Theory and random variables as an intrinsic need for the analysis of random phenomena.
2. Use the techniques and theory of linear algebra to model various real world problems.
3. Apply vectors in higher dimensional space in experimental data.
4. Use matrix in graph theory, linear combinations of quantum state in various fields of engineering.

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**PCIC 102 SYSTEM THEORY**

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**COURSE OBJECTIVES**

- To impart knowledge on modeling and representing systems in state variable form.
- To educate on solving linear and non-linear state equations and to illustrate the role of controllability and observability.
- To provide an overview on modal concepts and design of state feedback and state estimators.
- To introduce the concept of Non linear systems and apply describing function Techniques.
- To educate on stability analysis of systems using Lyapunov’s theory.

**Mathematical descriptions of systems:** Transfer function matrix - state space representation using physical, phase and canonical variables - comparison of input-output description and state variable description - mathematical description of composite systems.

**Solution of dynamical equation:** state transition matrix - impulse response matrix-controllability and observability- linear independence of time functions – Canonical form dynamical equations for single variable and multivariable cases - irreducible dynamical equation - controllability and observability of Jordan form dynamical equation - output controllability.

**State feedback:** Effects of state feedback, pole placement and feedback gain matrix- State estimators: Full-dimensional state estimator – reduced dimensional state estimator - connection of state feedback and state estimator - decoupling by state feedback.

**Non–linear Systems:** Behaviour of non-linear systems, jump resonance, subharmonic oscillation- Phase plane analysis: Singular points - construction of phase portraits using isocline, Lienard, Delta and Pells method - limit cycle analysis. Describing Function Techniques: Describing Function of nonlinearities - gain function and its determination for analytically and
graphically defined nonlinearities- conditions for stability - stability of oscillation - accuracy of Describing Function method - stability of systems with multiple nonlinearities – closedloop frequency response


**REFERENCES**


**COURSE OUTCOMES**

Upon completing the course, the student should

1. Understand basic principles of Transfer function model and State space model.
2. Acquire knowledge of state transition matrix, Controllability and Observability.
3. Understand the concepts of state feedback and state estimators.
5. Able to check and analyze stability of linear and non linear systems.

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COURSE OBJECTIVES

- To introduce the dynamics of various processes and modelling of physical process using first principles.
- To get adequate knowledge about basic control actions and related issues.
- To educate the effect of various control actions and the methods of tuning the controller.
- To introduce the concept of MIMO process and its control schemes.
- To study the control schemes for typical processes and its P&ID diagram.


Advanced control systems: Feedback control of systems with large dead time, dead time compensation – Cascade control – feed forward and ratio control – Adaptive and inferential control systems – internal model control - Model predictive control – Introduction to schemes of MPC.


Control of typical processes: Distillation column, control of top and bottom product composition, reflux ratio. CSTR, Four-tank system and PH process. piping and Instrumentation Drawing (P&ID) of control loops.

REFERENCES


**COURSE OUTCOMES**

At the completion of this course, students will be able to:

1. Understand basic principles and importance of process control in industrial process plants.
2. Acquire knowledge of dynamic modelling and system behaviour.
3. Understand the need for mathematical basis for the design of control systems.
4. Design and implementation of advanced controllers.
5. Understand the concept of MIMO process.

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**COURSE OBJECTIVES**

- To impart knowledge about the various techniques used for the measurement of primary industrial parameters like flow, level, temperature and pressure.
- To make the students understand about the important parameters to be monitored and analyzed in Thermal power plant and Nuclear power plant.
- To get an exposure on the important parameters to be monitored and analyzed in Petrochemical Industry.
- To learn about the intrinsic safety techniques adapted in industries.
To familiarize the students about the safety instrumented system and method to evaluate risk and safety instrumentation levels.

**Measurement of important process variables:**
Measurement principles of Temperature, Pressure, Level and Flow measuring instruments - General Considerations for Instrument mounting- Calibration principles for temperature and pressure transmitters- Semiconductor transducers for Temperature, Pressure, Level, and Flow.

**Instrumentation for Thermal power plant:**
Measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature - Selection and Installation of instruments for these variables - Dissolved oxygen analyzer - Flue gas analyzer - pH analyzer - Coal /oil analyzer - Pollution instruments-Dust monitor.

**Instrumentation for Nuclear power plant:**

**Instrumentation for Petrochemical industry/Refinery:**
Selection and installation of instruments for the measurement of temperature, level, flow and pressure in refinery – Measurements in Pyrolysis, Catalytic cracking and reforming processes-Hydrocarbon analyser-Sulphur in oil analyzer.

**Instrumentation for Industrial Safety:**
Intrinsic safety: Definition - Conservation and emergency vents - Flame, Fire and Smoke detectors - Leak detectors - Metal detectors. Safety Instrumentation System (SIS): need, features, components, difference between basic process control system and SIS.

Safety Integrity Levels (SIL), Determination Method : As Low As Reasonably Practical (ALARP), Evaluating Risk: Risk matrix, Risk Graph, Layers Of Protection Analysis (LOPA) – Issues related to system size and complexity – Issues related to field device safety.

**REFERENCES**
11. NPTEL Video Lectures on “Nuclear Reactors and Safety - An Introduction” by Dr. G. Vaidyanathan.

COURSE OUTCOMES
At the end of the course the students will be able to

1. Apply knowledge on measurement and calibration principles of basic industrial process variables to ensure proper functioning of industrial systems.
2. Appropriately select and mount the instruments for a particular process.
3. Execute instrumentation requirements in various process industries such as Thermal power plant and Nuclear power plant and Petro Chemical/ Refinery.
4. Identify hazardous area and ensure safety measures by evaluating risk levels and features.
5. Design and implement a safety instrumentation system.

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PCIC 107

PROCESS CONTROL AND INSTRUMENTATION LAB
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COURSE OBJECTIVES

- To impart knowledge about the modelling principle of level process and the characteristics of final control element and Controller.
- To design and implement tuning techniques of PID controller and verify in Matlab/Simulink environment.
- To design and implement closed loop control for processes like Air temperature, Air flow and Level.
- To familiarize the students with design and simulate cascade control for the given process.
- To Study the applications of Programmable Logic Controller.

**LIST OF EXPERIMENTS**

1. Determination of Control Valve characteristics
2. Determination of characteristics of capacitive level transmitter
3. Controller tuning using Continuous Cycling method
4. Modeling of an industrial Air Temperature Process
5. Study of Air flow control system and determination of transfer characteristics of I/P converter, Control Valve and Flow transmitter
6. Controller tuning using Process Reaction Curve method
7. Modeling and simulation of a Level process using TUTSIM
8. Determination of characteristics of a PID controller using MATLAB (Simulink) software
9. Determination of Transfer function (Experimental model) of Level process
10. Design and simulation of Averaging Control

**COURSE OUTCOMES**

At the end of the practical course the students will be able to

1. To model and design controllers for different processes.
2. To design and implement advanced control techniques.
3. Familiarize with TUTSIM and MATLAB software for process control applications.

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**PCIC 201 INDUSTRIAL DATA COMMUNICATION AND CONTROL**

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**COURSE OBJECTIVES**

- To provide fundamental knowledge about industrial data acquisition system and different industrial networking standards.
- To provide comprehensive knowledge about the methods of internetworking.
- To give basic knowledge in the architecture and local control unit of distributed control system.
To give adequate information about SCADA, PLC and OPC.
To give basic knowledge about HART, field bus, and control network technology.


MODEM: Data coding methods - error detection, correction and encryption. Fiber Optic transmission - Optical fiber Cables - light sources and detectors. Architecture of a PLC – Analog and digital types of I/O modules – PLC system memories - Program and data organization inside a PLC - Networking of multiple PLC.

Methods of Computer Control of Processes, their configuration and comparison: Direct Digital Control, Supervisory Digital Control, Distributed Control System (DCS).
DCS: Local Control Unit (LCU) and architecture - LCU languages - LCU - Process interfacing issues. Operator interface - requirements Engineering interface - requirements - displays - alarms and alarm management. Factors to be considered in selecting a DCS. Introduction to SCADA, OLE for Process control (OPC).

Network topology and media: OSI model - Data link Control protocol. Media access protocol: Command/response - Token passing - CSMA/CD, TCP/IP. Bridges - Routers - Gateways. Standard ETHERNET and Industrial ETHERNET Configuration - Special requirement for networks used for Control, Wireless LAN. Introduction to MODBUS, CANBUS, LON WORKS, FIP.

Field Bus: Introduction - General Field bus architecture - basic requirements of field bus standard - field bus topology - Interoperability - Interchangeability.

REFERENCES
4. NPTEL Notes on, “Programmable Logic Control System” by Department of Electrical Engg., IIT Kharagpur.

COURSE OUTCOMES
At the end of the course the students will be able to:
1. Understand the basic principle and modes of digital data transmission and communication.
2. Understand the various types of buses and devices used for data communication in industry.
3. Implement the automation concepts in a process industry like DCS and PLC.
4. Understand different networking topologies for data communication in process industries.
5. Use HART and FiledBus protocols for process industries.

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**COURSE OBJECTIVES**

- To make the students familiarize design orifice and control valve sizing.
- To impart knowledge on the design of signal conditioning circuits for the measurement of Level and temperature.
- To develop the skills needed to design and test Analog/ Digital PID controller, Data Acquisition System and Alarm Annunciator.

Orifice meter - design of orifice for given flow condition - design of rotameter. Control valves - design of actuators and positioners - valve characteristics - sizing of control valves - Liquid, Gas and steam services.


Design of cold junction compensation circuit for thermocouple using RTD. Transmitters - zero and span adjustment in D/P transmitters - Temperature transmitters- Design of RTD based Temperature Transmitter, Thermocouple based Temperature Transmitter, Capacitance based Level Transmitter and Smart Flow Transmitters. Design of flapper-nozzle and design of Pneumatic amplifiers.
Design of ON / OFF Controller using Linear Integrated Circuits- Electronic P+I+D controllers - design - adjustment of set point, bias and controller settings- Design of microprocessor based P+I+D controller - Design of microprocessor based system for data acquisition.

Design of Alarm and Annunciation circuits using analog and digital circuits – Design of Programmable Logic Controller - Design of configurable sequential controller using PLDs.

REFERENCES

COURSE OUTCOMES
1. Ability to carryout orifice and control valve sizing for Liquid/Steam Services.
2. Ability to design signal conditioning circuits for temperature sensors, V/I , I/V P/I and I/P converters.
3. Ability to design transmitters.
4. Ability to design, fabricate and test PID controllers and alarm circuits.

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PCIC 203 ADVANCED PROCESS CONTROL

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COURSE OBJECTIVES
- To review the processes with special characteristics.
- To study the fundamentals design and implementation of MPC.
- To study the concept of robust control system.
- To design and analyse optimal controllers.
• To understand and design controllers for MIMO process.

**Introduction to process control:** Review of first order and higher order systems, self and non-self regulatory processes, inverse response processes, non-minimum phase processes and open-loop unstable processes. Response to step, impulse and sinusoidal disturbances. Review of design and implementation of PID controller.

**Model based predictive control:** MPC strategy – MPC elements – prediction models – objective function – obtaining the control law – review of some MPC algorithms – Introduction to Non-linear predictive control. Implementation of Model Predictive Control for Heat exchanger and Distillation column.


**Optimal controllers:** H2 and H-INFINITY control – loop shaping design - Formulation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – Hinfinity estimation. LQG controller.

**Design of controllers for MIMO processes:** Introduction to Multivariable process control – selection of controlled outputs manipulation and measurements – RGA for square and non-square plants – Control configuration elements – centralized and decentralized feedback control – Trade-offs in MIMO feedback design.

**REFERENCES**


**COURSE OUTCOMES**

1. Able to analyse system behaviour.
2. Able to understand and design MPC for a given process.
3. Ability to design robust control system.
4. Able to understand the concept of H2 and H∞ controller.
5. Able to understand and design a Multi-Input Multi-Output system.

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**COURSE OBJECTIVES**

- To impart knowledge on various Non parametric approaches based system identification.
- To make the student understand the principles of State space modelling of linear and nonlinear systems.
- To know Non recursive and recursive parametric identification approaches.
- To learn to develop Robust parametric identification methods.
- To impart knowledge pertaining to practical aspects of system identification and control.


**Discrete time system models for control**: ARX models - bilinear parametric models – ARMAX,OE,BJ models - Hammerstein models – Wiener model –prediction error method and instrumental variable method. Selection of pseudo random binary sequence. **Recursive Plant Model identification in open-loop**: Identification methods - least squares - recursive least


**Nonlinear system identification:** Modeling of non linear system using ANN- NARX, NNSS,NARMAX- generation of training data – training Feed-Forward and Recurrent Neural Networks- TSK model- Adaptive Neuro-Fuzzy Inference system(ANFIS), Practical aspects of System identification and control: Selection of input signals - offline and online identification; notion for persistent excitation,drifts and de-trending-outliers and missing data-pre-filtering-robustness – comparison of parameter estimation methods – model order testing and verification-case studies.

**REFERENCES**

**COURSE OUTCOMES**
1. Will be able to identify a suitable continuous time domain identification method for the taken up process.
2. Ability to select particular state space model based on specific control engineering problem.
3. Understand and implement the various complexity estimation methods, offline and online, open and closed loop estimation methods for modelling and estimating a process.
4. Gain an idea for Robust parameter estimation.
5. Select a specific identification method with an approximately equal complexity for the case studies.
COURSE OBJECTIVES
- To impart knowledge about different digital Controller design.
- To design and implement tuning techniques of PID controller and verify in Matlab/Simulink environment.
- To design and implement closed loop control for processes like Air temperature, Air flow and Level using LABVIEW software.
- To familiarize the students with different logics in PLC and its implementation for automation applications.
- To study the applications of SCADA and DCS for process automation applications.

LIST OF EXPERIMENTS
1. Design and Simulation of Dead-beat controller using TUTSIM
2. a) Design of Dead time compensator using smith predictor algorithm using MATLAB/SIMULINK
   b) Design and Simulation of Inverse response compensator using MATLAB/SIMULINK
3. Study of LABVIEW software
4. a) Study of Programmable Logic controller (Keyence PLC)
   b) Direction Control of DC motor using PLC
5. Study of SCADA software (Intouchwonderware)
6. PC based control of a simulated process
7. Design of Fuzzy & Neuro controller for a Pressure Process
8. Study of DCS (Centum CS 3000)

COURSE OUTCOMES
At the end of the practical course the students will be able to
1. To model and design digital controllers for different processes.
2. To design and implement artificial intelligence based control techniques.
3. Get hands on experience for PLC interfacing with real time applications.
4. Familiarize with LabView and SCADA software for process control applications.
COURSE OBJECTIVES
- To work on a technical topics related to process control and Instrumentation Engineering and acquire the ability of written and oral presentation.
- To acquire the ability of writing technical papers for Conferences and Journals.

The students will work for two periods per week guided by student counsellor. They will be asked to present a seminar of not less than fifteen minutes and not more than thirty minutes on any technical topic of student’s choice related to their specialization in Process Control and Instrumentation Engineering and to engage in discussion with audience. They will defend their presentation. A brief copy of their presentation also should be submitted. Evaluation will be done by the student counselor based on the technical presentation and the report and also on the interaction shown during the seminar.

COURSE OUTCOMES
1. The students will be getting the training to face the audience and to interact with the audience with confidence.
2. To tackle any problem during group discussion in the corporate interviews.

COURSE OBJECTIVES
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES
Upon completion of this course, the students will be able to:
1. Take up any challenging practical problems and find solution
2. Learn to adopt systematic and step-by-step problem solving methodology

Mapping with Programme Outcomes

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**COURSE OBJECTIVES**

- To train the students in the field work related to process control and instrumentation and to have a practical knowledge in carrying out process control and instrumentation field related works.
- To train and develop skills in solving problems during execution of certain works related to process control and instrumentation.

The students individually undergo a training program in reputed concerns in the field of Process Control and Instrumentation during the summer vacation (at the end of second semester for full – time / fourth semester for part – time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training they had, within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

**COURSE OUTCOMES**

1. The students can face the challenges in the practice with confidence.
2. The student will be benefited by the training with managing the situation arises during the execution of works related to Process Control and Instrumentation.

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**COURSE OBJECTIVES**

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to:
1. Take up any challenging practical problems and find solution.

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PROFESSIONAL ELECTIVE COURSES

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COURSE OBJECTIVES

- To review the mathematical basis of discrete time signal analysis.
- To discuss the estimation theory and predictors.
- To design and implement adaptive filters.
- To study the techniques of modern signal processing applications using multirate transforms.


**Linear Estimation And Prediction:** Maximum likelihood criterion- efficiency of estimator -least mean squared error criterion-wiener filter discrete wiener Hoff equations-Recursive estimators - Kalman filter- linear prediction, prediction error- whitening filter, inverse filter-Levin son recursion, Lattice recursion, Lattice realization and Levinson recursion algorithm for solving Toeplitz system of equations.


REFERENCES


COURSE OUTCOMES
At the end of the course the students will be able to
1. Analyse the functions and characteristics of different op-amps.
2. Familiarize with various estimation techniques.
3. Able to realize systems using different realization algorithms.
4. Able to analyze and implement different types of adaptive filters.
5. Familiarize with multirate wavelet transform and its implementation.

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COURSE OBJECTIVES
- To impart knowledge on the embedded controllers and embedded software development process.
- To understand the concepts of real time operating systems.

Embedded Controllers: 8051 and PIC 16F877 :Architecture - Memory Organization - Addressing Modes- Instruction sets – Simple programs.

**RTOS Based Embedded System Design:** Basic concepts of RTOS – Tasks, Processes and Threads – Multiprocessing and Multitasking – Task Scheduling – Task Communication – Task Synchronisation – Device Drivers – Interrupt Processing – Memory Management – Message Queues - Comparison and study of various RTOS such as Windows CE, Embedded Linux, μcos, QNX, VXWORKS and Nucleus.

**REFERENCES**


**COURSE OUTCOMES**

1. Will gain knowledge on the embedded controllers and embedded peripherals.
2. Ability to select embedded hardware components & its interface
3. Gain knowledge on embedded software development process
4. Will be able to know the basics of real time operating systems.

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COURSE OBJECTIVES

- To understand the machine learning theory.
- To train linear and non-linear learning models.
- To build tree and ensemble based models.
- To implement clustering & dimensionality reduction techniques.
- To apply reinforcement learning techniques.

Foundations of Learning:


Linear Models:


Tree and Ensemble Models


Unsupervised Learning


Reinforcement Learning


REFERENCES

5. Stanfod CS229 Course: http://cs229.stanford.edu
6. Stanfod CS229 Course: https://www.youtube.com/playlist?list=PLA89DCFA6ADACE599

**COURSE OUTCOMES**

1. Ability to understand the basic theory underlying machine learning.
2. Will be able to understand a range of machine learning algorithms along with their strengths and weaknesses.
3. Will be able to formulate machine learning problems corresponding to different applications.
4. Will be able to apply machine learning algorithms to solve problems of moderate complexity.

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**COURSE OBJECTIVES**

- To study about the statement of optimal control problem, formulation of optimal control problem and selection of performance measure.
- To understand the concepts of fundamental concepts of calculus of variation and variational approach to optimal control problems.
- To derive the expression for continuous and discrete linear optimal regulator problem.
- To study about the concepts of dynamic programming and its application.
- To understand the concept of numerical solution of two point boundary value problem.
Optimal Control Problems and Performance Measures

Calculus of Variation
Fundamental concepts – extremumfunctionals involving single and several independent functions - Final time and final state are fixed - Final time is fixed and final state is free - Final time is free and final state is fixed - Both final time and final state are free. Piecewise smooth extremals - constrained extrema.

Variational Approach to Optimal Problems
Necessary conditions for optimal control - Pontriyagin's minimum principle - state inequality constraints - minimum time problem - minimum control effort problems.

LQ Control Problem

Dynamic Programming

REFERENCES

COURSE OUTCOMES
After completion of this paper the student will have
1. Ability to understand the optimal control problem formulation and its selection of performance measures.
2. Ability to recognize and recall the fundamentals of calculus of variation.
3. Ability to implement optimal control concept for minimum time and minimum control effort problems.
4. Ability to apply Matrix Ricatti Equation for real world problem.
5. Ability to understand the concepts of dynamic programming and to find numerical solution of two-point boundary value problem.

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## COURSE OBJECTIVES

1. To familiarize the students with concepts of fiber optic sensors, modulating techniques and measurement methods.
2. To impart knowledge about laser instrumentation and its application in industry.
3. To equip the students the principle and application of ultrasonic instrumentation systems.
4. To learn about virtual instrumentation including loops, arrays and file I/O.
5. To understand about the smart instruments used in transmitters, communication and measurement systems.

### Fiber Optic Instrumentation


### Laser Instrumentation


### Ultrasonic Instrumentation

Principle and propagation of Ultrasonic waves- Characterization of ultrasonic transmission- Reflection and transmission coefficients-Generation of ultrasonic waves-Magnetostrictive and piezoelectric effects- Ultrasonic test methods-pulse echo, transit time, resonance, direct contact and immersion type-Measurement of thickness, depth, flow using ultrasonic sensors.
Virtual Instrumentation
Block diagram and architecture of virtual instrumentation- VI’s and sub VI’s- Loops and charts- Arrays, Clusters and Graphs-Case and sequence structures-Formula nodes, local and global variables- String and file I/O- Instrument drivers- Publishing data in the web.-Simulation of system using VI- Development of virtual instrument using GUI.

Smart Measuring Instruments
Smart/Intelligent transducer- Comparison with conventional transducers- Self diagnosis and remote calibration features- Smart transmitter with HART communicator protocol -Measurement of temperature, pressure and Flow using HART transmitter.

REFERENCES

COURSE OUTCOMES
At the end of the course the students will be able to
1. Select fiber optic sensors and Design a fiber optic based instrumentation system for the measurement of industrial process variables.
2. Apply the principle of Lasers and develop laser based measuring instrumentation system.
3. Develop ultrasonic instrumentation system for measurement and analysis.
4. To design systems applying virtual instrumentation principles.
5. Handle smart instruments and HART transmitters.

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COURSE OBJECTIVES

- To impart knowledge on how to recursively estimate the parameters of discrete input–output models (ARX/ARMAX etc) using recursive parameter estimation methods.
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To craft the student design simple adaptive controllers for linear systems using above methods.

Introduction
Introduction to System Identification: – Adaptive Control Vs Conventional feedback control - adaptive control schemes.

Gain scheduling and Model Reference Adaptive System

Deterministic self-tuning regulators

Stochastic self-tuning regulators

Robust Self-Tuning Regulators, Practical aspects and Case studies
Temperature control in a distillation column, chemical reactor control, pulp dryer control & control of a rolling mill.
REFERENCES

COURSE OUTCOMES
1. Will be able to design simple adaptive controllers for linear systems.
2. Ability to identify, formulate analyse the adaptive controllers.
3. Ability to implement adaptive controllers to engineering problems.

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PCIE X0X | FAULT TOLERANT CONTROL |
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COURSE OBJECTIVES
- To understand different faults that occurs in sensors and actuators.
- To identify kind, size and magnitude of the fault by model based and model free methods.
- To understand the structured residuals and directional structured residuals.
- To understand the methods to estimates the faults.

Introduction to Fault Detection and Diagnosis (FDD)
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.
Analytical Redundancy Concepts

Design of Structured Residuals
Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.

Design of Directional Structured Residuals

Data Driven Methods
Principal Component Analysis – Partial Least Squares - Canonical Variate Analysis – Knowledge Based Methods.

REFERENCES

COURSE OUTCOMES
1. Ability to Understand different approaches to Fault Detection and Diagnosis
2. Ability to Estimate the kind, size, type and time of occurrence of faults by analytical methods.
3. Ability to design and detect single and multiple faults using structured residual approach
4. Ability to design and detect single and multiple faults using directional structured residual approach
5. Ability to Understand the data driven methods like PCA, partial least square methods.

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RSE OBJECTIVES

- To make the students understand the purpose and uses of SPC.
- To use the most common types of control charts and carry out process capability studies.
- To import knowledge about various SPC tools, data collection and construct basic control charts.
- To make the students understand concept of control charts for variables and attributes and how to interpret control chart results.
- To impart knowledge of other statistical process monitoring and control techniques.

Quality Improvement In The Modern Business Environment
The Meaning of Quality and Quality Improvement, Dimensions of Quality, Quality Engineering Terminology, A Brief History of Quality Control and Improvement, Statistical Methods for Quality Control and Improvement, univariate process monitoring and control.

Methods And Philosophy Of Statistical Process Control

Control Charts for Variables
Control Charts for X and R, Statistical Basis of the Charts, development and Use of X and R Charts, Charts Based on Standard Values, Interpretation of X and R Charts. The Effect of Non normality on X and R Charts, The Operating Characteristic Function, The Average Run Length for the X Chart, Control Charts for –x and s, Construction and operation of X and s charts, The X and s Control Charts with Variable Sample size, Summary of Procedures for X and R, and s Charts, Applications of Variables Control Charts.

Control Charts For Attributes
The Control Chart for Fraction Nonconforming, Development and Operation of the Control Chart Variable Sample Size, Applications in Transactional and Service Business, The Operating Characteristic Function and Average Run Calculations, Control Charts for Nonconformities (Defects).

Other Statistical Process Monitoring And Control Technique
The Cumulative Sum Control Chart, Basic Principles: The CUSUM Control Chart for Monitoring the Process Mean, The Tabular or Algorithmic Cusum for Monitoring the Process Mean, Recommendations for Cusum Design, Exponential weighted moving average [EWMA],
EWMA for Monitoring the Process Mean, design of EWMA, combining EPC[Engineering process control] and SPC, MINITAB software.

REFERENCES

COURSE OUTCOMES
1. Able to analyse quality control in industries.
2. Able to understand SPC and its design tools.
3. Ability to construct control charts.
4. Able to understand the concept of variable and attribute charts.
5. Able to understand process monitoring and control techniques.

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COURSE OBJECTIVES
- To introduce the basic concepts of micro systems and advantages of miniaturization.
- To teach the fundamentals of micromachining and micro fabrication techniques.
- To train the students on the design of micro sensors and actuators and fabrication flow process.

PCIE X0X MEMS DESIGN AND FABRICATION

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To impart knowledge on various packaging technologies for MEMS.


REFERENCES

**COURSE OUTCOMES**

At the end of the course the students will be able to

1. Know the basic concepts of micro systems and advantages of miniaturization.
2. Understand the fundamentals of micromachining and micro fabrication techniques.
3. Expertise the knowledge in design of micro sensors and actuators fabrication.
4. Develop various packaging techniques in the design of MEMS.

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**COURSE OBJECTIVES**

- To make the students to understand the role of electronics and software related to current trends in automobiles.
- To provide fundamental knowledge of sensors and other technologies used in modern automobiles.
- To provide a strong knowledge on control system to improve safety measures and also to increase comforts of users.
- To impart knowledge on Automotive standards and protocols.

**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.

Automotive standards, protocols and energy management
Automotive standards like CAN protocol, LIN protocol, flex ray, OBD-II, CAN FD, automotive Ethernet etc. Automotive standards like MISRA, functional safety standards (ISO 26262). BMS (battery management system), FCM (fuel control module), principles of system design, assembly process of automobiles and instrumentation systems.

REFERENCES

COURSE OUTCOMES
After learning this course, the students should be able to:
1. Evaluate the sensor and measuring system of automobile.
2. Design the basic modeling and control scheme for automotive systems.
3. Acquire knowledge of various automotive standards and Protocols.
COURSE OBJECTIVES

- To learn about electric drives & its types.
- To acquire knowledge about the circuit model of electric motors.
- To implement the power converters for the drives by efficient control algorithms.
- To understand the need for the digital controllers.
- To study about the generation of control pulses for power electronic converters and their applications.

Introduction to electric drives: Classification, characteristics and advantages of electric drives – Speed- torque characteristics of various types of loads and drive motors – Joint speed- torque characteristics - Selection of power rating for drive motor based on thermal limits – Overload capacity – Starting, braking and reversing methods for various types of motors.


Control of DC drives: Analysis of series and separately excited DC motor with single phase converters operating in different modes and configurations – Analysis of series and separately excited DC motor fed from different choppers – two quadrant and four quadrant operation – Closed loop control of dc drives – Design and analysis of controllers for load changes.

source inverter drive with open loop control static rotor resistance control and slip power recovery scheme.

**Digital techniques in speed control:** Advantages and limitations – Microprocessor, microcontroller and PLC based control of drives – Selection of drives and Control schemes for paper mills, cement mills, sugar mills.

**REFERENCES**


**COURSE OUTCOMES**

1. Get a thorough understanding of motor-load system dynamics and stability, modern drive system objectives and fundamentals of dc and ac motors.
2. Will have the ability to model both dc and ac motors in various conventional methods.
3. Confidently design and analyze both converter and chopper driven dc drives.
4. Will have a thorough understanding of conventional control techniques of AC drives and will have the ability to design and analyze such system.
5. Get a detailed knowledge on advanced high performance control strategies for AC drives and emerging technologies in electric drives.

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**COURSE OBJECTIVES**

- To introduce the technologies and applications for the emerging domain of wireless sensor networks.
- To impart knowledge on the design and development of the various layers in the WSN protocol stack.
- To elaborate the various issues related to WSN implementations.
- To familiarize the students with the hardware and software platforms used in the design of WSN.

**Introduction:** Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture – Hardware components, energy consumption of sensor nodes, Network architecture – Sensor network scenarios, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, design principles, Development of wireless sensor networks.

**Physical Layer:** Wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication, packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, energy usage profile, choice of modulation, power management.

**Data Link Layer:** MAC protocols – fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols, Link Layer protocols – fundamentals task and requirements, error control, framing, link management.

**Network Layer:** Gossiping and agent-based uni-cast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, mobile nodes, Data-centric and content-based networking – Data-centric routing, Data aggregation, Data-centric storage, Higher layer design issue.


**REFERENCES**

COURSE OUTCOMES
1. Ability to analyze WSN with respect to various performance parameters in the protocol stack.
2. Ability to understand MAC algorithms and Network protocols used for specific WSN applications.
3. Design and develop a WSN for a given application.

COURSE OBJECTIVES
- To provide a fundamental understanding of circuit and physical design of Integrated circuits, and a summary of CMOS processing technology.
- To learn the models for transistors to predict the transfer characteristics CMOS Inverters and to address performance estimation for circuits.
- To learn simulation tools to obtain more accurate predictions as well as to verify the correctness of circuits and logic.
- To understand the combinational circuit design and sequential circuit design including clocking and latching techniques.
- To provide subsystem view of CMOS design such as datapath subsystems, memory subsystems and special purpose systems.


Combinational circuit design: Circuit families – Low-power logic design - Comparison of circuit families. Sequential circuit Design: Sequencing static circuits - Circuit design of Latches and FFs - Static sequencing element methodology - Sequencing dynamic circuits - Synchronizers.


**REFERENCES**

**COURSE OUTCOMES**
At the end of the course the students will know
1. The principles required to design and lay out a simple CMOS chip on their own.
2. Models for transistors and simulation techniques to characterize a process and to check performance, power and correctness of circuits and interconnect.
3. A range of datapath subsystems, array subsystems and special purpose analog circuits.
4. A range of design methods that can be used to implement a CMOS system.
5. The issues in CMOS chip testing and the methods for incorporating test considerations into chips from the start of the design.

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**COURSE OBJECTIVES**
- To study the basics of image processing and its applications.
- To familiarize with image enhancement and image compression techniques.
- To learn about image restoration techniques and implementation of projection algorithms.

**Digital Image Processing:** Origin– components - examples of fields that use DIP.
Digital Image Fundamentals: Elements of visual perception, light and the EM spectrum, a simple image formation model, image sampling and quantization, some basic relationships between pixels. Image transforms - Two dimensional orthogonal and unitary transforms - properties of unitary transform.


**Image Compression and Segmentation:** Compression models - elements of information theory - error free compression - run length coding - loss less and lossy predictive coding - image compression standards. Image Segmentation - Detection of discontinuities, point, line and edge detections, gradient operators, Laplacian, edge linking and boundary detection, thresholding, region based segmentation.


**Image reconstruction from projections:** Radon transform-inverse radon transform back projection operator-convolution back projection- parallel beam geometry-Fan beam geometry. MRI Fourier reconstruction.

**REFERENCES**

**COURSE OUTCOMES**
At the end of the course the students will be able to
1. Analyse the basics of image processing.
2. Familiarize with image enhancement techniques.
3. Able to compress an image using various compression techniques.
4. Able to restore an image from its degraded version.
COURSE OBJECTIVES

- To learn the concepts and techniques used in sensor data fusion.
- To understand the role of Mathematical tools used.
- To elaborate the concept of Kalman filter to data fusion problems.
- To impart knowledge on advanced filtering techniques.


Mathematical tools used: Algorithms, Taxonomy of algorithms for multisensor data fusion coordinate transformations, rigid body motion, Dependability and Markov chains, Meta – heuristics, Data association, Identity declaration.

Estimation: Kalman filtering, practical aspects of Kalman filtering, Extended Kalman filters, Partical filter, Decision level identifi fusion, Knowledge based approaches.

Advanced Filtering: Data information filter, extended information filter, Decentralized and scalable decentralized estimation, Sensor fusion and approximate agreement, Optimal sensor fusion using range trees recursively, Distributed dynamic sensor fusion.


REFERENCES

COURSE OUTCOMES
At the end of the course the candidate will be able to
1. Understand the importance of using data fusion in multi-sensor systems.
2. Understand simple approaches to data fusion for enhancing sensor reliability.
3. Derive and apply the Kalman filter to data fusion problems.
4. Understand the importance of sensor management and data association.
COURSE OBJECTIVES

- To enable the students to conceive and understand the basics of signal processing.
- To gain knowledge about transforms and filters.
- To familiarize with bio electric signals and their processing.


Time and Frequency domain analysis: Fourier spectrum of bio signals, Short time Fourier transform and spectrogram, DCT and its applications for bio signals. Correlation analysis and power spectral estimation of bio signals.

Digital Filters for bio signal applications: Illustration of different types of artifacts and noise –

- time domain filters – frequency domain filters – notch and comb filters – optimal filtering –
- adaptive filters – filters for signal decomposition.


Overview of Bio Signal Processing: Heart rate variability analysis – ECG wave delineation –

- ECG beat classification – brain wave classification – event change detection and augmented reality medical systems.

REFERENCES


COURSE OUTCOMES

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

1. Review the characteristics of bio signals.
2. Carry out data reduction and compression processes.
3. Design and analyze bio signals.
4. Process appropriate bio electric signals.
5. Perform Feature Extraction Techniques.