UNIVERSITY OF MUMBAI

Syllabus

Program: Bachelor of Engineering

Course: Instrumentation Engineering
(R – 2012)

B. E. - Sem. VII & VIII

(As Per Credit Based Semester and Grading System with effect from the Academic year 2015–2016)
From Dean’s Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO’s) and give freedom to affiliated Institutes to add few (PEO’s) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner’s learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner’s performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

University of Mumbai, Instrumentation Engineering, Rev 2012-13 1
Preamble:
The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and also to achieve recognition of the institution or program meeting certain specified standards. The main focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for undergraduate program in Electrical Engineering, more than twenty senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for undergraduate program in Electrical Engineering are listed below;

- To provide the overall strong technical foundation to formulate, solve and analyse engineering problems during undergraduate program.
- To prepare students to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare students to demonstrate ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare students for successful career in industry, research and development.
- To develop the ability among students for supervisory control and data acquisition for power system application.
- To provide opportunity for students to handle the multidisciplinary projects.
- To create the awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

The affiliated institutes may include their own PEOs in addition to the above list to support the philosophy of outcome based education, in addition to stated PEOs, objectives and expected outcomes are also included in the curriculum. I know, this is a small step taken to enhance and provide the quality education to the stake holders.

Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

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### Semester VII

<table>
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<tr>
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* Includes both Practical and Oral examination
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<td>Advanced Embedded System</td>
<td>ISE8041</td>
<td>Nuclear Instrumentation</td>
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<td>ISE7052</td>
<td>Image Processing</td>
<td>ISE8042</td>
<td>Power Plant Instrumentation</td>
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<td>Functional Safety</td>
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<td>ISE7054</td>
<td>Process Modeling &amp; Optimization</td>
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<td>Nano Technology</td>
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<td>ISE7055</td>
<td>Wireless communication</td>
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<td>Fiber Optic Instrumentation</td>
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**Project Guidelines**

Project –I and II: Students groups and load of faculty per week

Project Groups: Students can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load: In semester VII - 1 (one) period of 1 hour per week per project group
In semester VIII - 2 (Two) period of 1 hour each per week per project group
Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

Note: The project load for students in VII semester is 6hrs and 12 hrs in VIII semester.
<table>
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<tr>
<td>ISC701</td>
<td>Industrial Process Control</td>
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</table>

**Course Objectives**
- To make the students understand all the processes involved in the industries, the various unit operations and be able to apply control schemes to these processes to get the output with desired specifications.
- To make the students acquainted with safety and hazards in industry.

**Course Outcomes**
The students will be able to
- Get a complete overview of strategies for process control.
- Know all the industrial processes and demonstrate their knowledge in designing the control loops for these processes.
- Understand the safety related terms such as classification of hazards in the industry and design Hazard free plant.
<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 1      | **Control System for Heat transfer unit operations:**  
Heat exchangers: classification as per fluid flow arrangement and construction, feedback, feed-forward, bypass control schemes, fouling in heat exchangers.  
Boiler controls: Basic designs of boilers- fire-tube and water-tube boilers. Typical boiler equipment. Terms related- Shrink and swell effect and excess oxygen, boiler efficiency. Boiler controls- Steam temperature control, Boiler pressure control, Combustion control-Type 1,2,3 and 4, Drum level control-Single, two and three element, Furnace draft control, safety interlocks and Burner Management System.  
Evaporator control: Evaporator terminologies, Types of Evaporator and multiple effect evaporator, control systems for Evaporator – feedback, cascade, feed forward and selective control.  
Furnace control: Start- up heaters, fired re-boilers, process and safety controls. | 13 |
| 2      | **Control System for Heat and mass transfer unit operations**  
Distillation column: Basic principle, Distillation equipment and its accessories. Batch and continuous distillation, Binary product distillation, multi-product distillation, side-draw product distillation column. Distillation column control strategies- Top and bottom product composition controls, Using chromatograph, Pressure controls, Vacuum distillation, Vapour recompression and pressure control, Feed controls- Column feed controls and Feed temperature control, economizer  
Dryer control: Process of drying, types of dryer- Tray, Vacuum dryer, fluidized bed, Double drum dryer, rotary, turbo and spray, and their control strategies.  
Crystallizers: Super-saturation methods, Process of crystallization, types of crystallizer, control of evaporating crystallizer, cooling crystallizers, vacuum crystallizers.  
Reactor control: Reactor characteristics, runaway reaction, various schemes of temperature control of reactors. | 12 |
| 3      | **Miscellaneous process equipments**  
Compressor- Classification, Phenomenon of Surge for centrifugal compressors, Methods of surge control for compressors.  
Gas turbine- Introduction, gas turbine layouts, closed cycle gas turbine, Engine controls. | 05 |
| 4      | **Continuous Process Industries:**  
Refinery Industry: Process flow diagram, separation, treatment-Hydrodesulphurization unit, conversion methods- Fluid Catalytic Cracking, blending, sensors and ctrl schemes. | 07 |

| 5 | Batch Process Industries:  
Food processing: Milk pasteurization.  
Pharmaceutical industries- Penicillin-G production, sensors and control schemes |
|---|---|

| 6 | Safety in Instrumentation control systems:  
Area and material classification as per IEC and NEC standard, techniques used to reduce explosion hazards, intrinsic safety, and installation of intrinsically safe systems. |

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Oral Examination:
Practical/Oral examination will be based on entire syllabus.

Term work:
Term work consists of minimum six assignments/experiments, two case studies related to process industries, may be analytical or through Industrial visit. Suggested experiments may contain Process and Control Simulation on Distillation Column, Heat Exchanger etc.

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Assignments / journal) : 10 Marks
Attendance (Theory and Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.
Text Books :


Reference Books :

<table>
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<tr>
<th>Sub code</th>
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<td>ISC702</td>
<td>Biomedical Instrumentation</td>
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</table>

**Course Objectives**

- To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement and application of these instruments in diagnosis, therapeutic treatment and imaging fields.

**Course Outcomes**

- The students will be able to
  - Identify various Bio-potential and their specifications in terms of amplitude and frequency.
  - Understand principle and working of various Biomedical Instruments for diagnosis applications.
  - Decide the applications of therapeutic instruments for treatment purpose.
  - Understand applications of imaging instruments and the modalities involved in each technique.

**Module**

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<td>electrical activity of cell their</td>
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<td>characteristic and specifications.</td>
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<td>Measurement of RMP and AP. Electrode-</td>
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<td>Electrolyte interface and types of bio-</td>
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<td><strong>2</strong> Physiological Systems and Related</td>
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<td>Cardiovascular system- Structure of Heart,</td>
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<td>Electrical and Mechanical activity of Heart,</td>
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<td>ECG measurements and Cardiac arrhythmias.</td>
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<td>Nervous system- Nerve cell, neuronal</td>
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<td>CNS, PNS. Generation of EEG and its</td>
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<td>evoked potential and epilepsy.</td>
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<td>Muscular system- Generation of EMG signal,</td>
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<td>specification and measurement.</td>
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Design of ECG amplifier.

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<th>Cardiovascular Measurement:</th>
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<td>3</td>
<td>Blood Pressure- Direct and Indirect types, Blood Flow- Electromagnetic and Ultrasonic types, Blood Volume- Types of Plethysmography. (Impedance, Capacitive and Photoelectric), Cardiac Output- Flicks method, Dye-dilution and Thermo-dilution type, Heart sound measurement.</td>
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<td>6</td>
<td>Physiological effects of electrical current, Shock Hazards from electrical equipment and methods of accident prevention.</td>
<td>02</td>
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</table>

* One Hospital Visit is recommended for imaging Instruments.

**List of Experiments:**

1. Demonstration and working of instruments like EMG, EEG and ECG.
2. Study of electrodes for various applications.
3. To measure Blood pressure by indirect method.
4. To study Pacemaker and various waveforms or Design and implement Pacemaker CKT.
5. To study Defibrillator and voltage waveforms or Design and implement Defibrillator CKT.
6. Design of ECG amplifier and testing of gain frequency response with weak input signal.
7. To design and implement ECG signal conditioning circuits with different parameter.
8. To design and implement EMG quantification Circuit.
10. ECG simulation on PC.
11. ECG Simulation using Microcontroller.

**Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

University of Mumbai, Instrumentation Engineering, Rev 2012-13  11
Practical/Oral Examination:
Oral examination will be based on entire syllabus and experiments performed.

Term Work:

Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Assignments / journal) : 10 Marks
Attendance (Theory and Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

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<tr>
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<td>Advanced Control system</td>
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**Course Objectives**
- To make students understand the concept of non linear control, Internal Model Control and Optimal Control.
- To Study the stability of Non Linear and Linear systems.

**Course Outcomes**
- The Students will be able to
  - Linearize the non linear physical systems.
  - Study the non linear system behavior by phase plane and describing function methods
  - Study the stability of linear and nonlinear systems by Lyapunov method.
  - Design IMC with Uncertainty and Disturbances.

<table>
<thead>
<tr>
<th>Module</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite</td>
<td>Modeling of linear systems, Simulation of system, System stability through transient response and frequency response techniques. Superposition theorem for differentiating linear and nonlinear systems.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td><strong>Introduction</strong>&lt;br&gt;Norms for Signals and Systems, Input-Output relationships,&lt;br&gt;<strong>Nonlinear Control Systems</strong>&lt;br&gt;Definition of nonlinear systems, Difference between linear and nonlinear systems, characteristics of nonlinear systems, Common physical nonlinearities&lt;br&gt;<strong>Linearization Methods</strong>&lt;br&gt;Jacobian Linearization, Concept of relative degree, Feedback linearization for systems with no internal dynamics.</td>
<td>8</td>
</tr>
</tbody>
</table>
### 2. Phase-plane Analysis
Phase-plane Analysis, Basic concepts, phase-trajectories, phase portrait, Constructing phase portraits-Analytical Methods, Graphical Method - Delta Method, Determining Time from Phase Portraits, Singular points and their classification, limit cycles and behavior of limit cycles.

### 3. Describing Function Analysis
Describing Function Fundamentals, Describing Functions of saturation, dead zone, relay and their combinations, Stability analysis of nonlinear systems via describing function method.

### 4. Lyapunov Stability Analysis

### 5. Internal Model Control
Introduction to Model-Based Control, Open loop controller Design, Model Uncertainty and Disturbances, Development of IMC structure, IMC-Based PID Controller Design.

### 6. Optimal Control
Problem Formulation, Continuous linear regulator problem (LQR), Solution via Control Algebraic Riccati Equation (CARE)

### List of Laboratory Experiments

- **Nonlinear Control System and Analysis**
  a) Construct the trajectory for system represented by second order differential equation and for any initial condition by using Delta Method.
  b) Draw the trajectory for the system with nonlinear element – relay, saturation, etc. for any initial condition and step input by using Delta Methods.
  c) Study behavior of limit cycle with the help of Vander Pol's equation.
  d) Derivation of DF for nonlinearities – relay with saturation, relay with dead-zone, dead-zone and saturation etc.
  e) Investigate the stability of system with nonlinearities – relay, saturation, dead-zone and existence of limit cycle using DF technique.

- **Lyapunov Stability Analysis**
  a) Verify Sylvester theorem for the definiteness of the Lyapunov Function.
  b) Determine the stability of the system and construct the Lyapunov function for Linear Time Invariant system.
  c) By using Krasovskii method determine the stability of the system and construct the Lyapunov function.
  d) By using Variable Gradient method determine the stability of the nonlinear system.
• Internal Model Control
  a) Effect of filter tuning parameter on step response of the first and second order systems.
  b) Design of IMC controller for a system subject to step input.
  c) Design of IMC controller for a system subject to ramp input.
  d) Design of IMC based PID controller.
  e) Design of IMC controller for delay and non-minimum phase systems.

• Optimal Control
  a) Obtain control for the second order system using given Quadratic Function.
  b) Obtain control for the second order system via solution of Riccati Equation.

Theory Examination:

1. Question paper will consist of total 6 questions carrying 20 marks each.
2. Only 4 questions need to be attempted.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.
6. No questions should be asked from the prerequisite module.

Term work:

Term work consists of minimum eight experiments, two case studies and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) : 15 marks
Test (at least one) : 10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.
Text Books:


Reference Books:

1. Slotine, Li - “Applied Nonlinear Control”
### Subject Code: ISC704  
**Subject Name:** Process Automation  
**Credits:** 5

#### Course Objectives
- To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA. Students should understand the working of these systems and should be able to determine hardware and software requirements of PLC, DCS and SCADA. They should further understand how to design any application based on these systems. Also they should understand the requirements of safety and design safety instrumented systems.

#### Course Outcomes
- The students will be able to
  - Define automation, it’s importance, expectations from automation and applications in industry.
  - Understand working of PLC, I/O modules of PLC, Programming languages and instructions of PLC, design PLC based application by proper selection and sizing criteria, developing GUI and ladder program.
  - Understand evolution and architecture of DCS, hierarchical control in DCS, programming DCS through function Block Diagram (FBD) method.
  - SCADA architecture, communication in SCADA, develop any application based on SCADA along with GUI using SCADA software.
  - Understand the need of SIS, risk reduction methods, evaluation of SIL (Safety Integrity Levels)

#### Module

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 1      | Automation Fundamentals  
Types of plant and control – categories in industry, open loop and close loop | 04 |
control functions, continuous processes, discrete processes, and mixed processes.  
Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control.  
Control system architecture – evolution and current trends, comparison of different architectures.

### 2 Programmable Logic Controller

**Hardware**
Evolution of PLC, Definition, functions of PLC, Advantages, Architecture, working of PLC, Scan time, Types & Specifications.  
DI-DO-AI-AO examples and ratings, I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules, Memory & addressing- memory organization (system memory and application memory), I/O addressing, hardware to software interface.

**Software**
Development of Relay Logic Ladder Diagram, introduction to PLC Programming, programming devices, IEC standard PLC programming languages, LD programming- basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC.

**Case study:**
PLC selection and configuration for any one process applications.

### 3 Distributed Control System (DCS)

Introduction to DCS, Evolution of DCS, DCS flow sheet symbols, architecture of DCS, Controller, Input and output modules, Communication module, data highway, local I/O bus, Workstations, Specifications of DCS.

Introduction of Hierarchical control of memory: Task listing, Higher and Lower computer level task.

Supervisory computer tasks DCS configuration. Supervisory computer functions, Control techniques, Supervisory Control Algorithm. DCS & Supervisory computer displays, advanced control Strategies, computer interface with DCS.

DCS. System integration with PLCs computer: HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks.

Introduction to DCS Programming, Function Block Diagram method for DCS programming.

### 4 Supervisory Control and Data Acquisition (SCADA)

SCADA introduction, brief history of SCADA, elements of SCADA.

Features of SCADA, MTU- functions of MTU, RTU- Functions of RTU, Protocol Detail

SCADA as a real time system Communications in SCADA- types &
## List of Experiments:

1. Manipulation of sensor signals by the PLC to drive various end effectors such as pneumatic/electric/hydraulic
2. 4 PLC programs for process control applications
3. DCS programming using Function block diagram method
4. GUI development for any one application using SCADA software.

## Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

## Oral Examination:

Oral examination will be based on entire subject

## Term Work:

Term work shall consists of minimua 4 experiments and four assignments.
The distribution of marks for term work shall be as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Marks</th>
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<tr>
<td>Laboratory work (Experiments)</td>
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</tr>
<tr>
<td>Laboratory work (programs / journal)</td>
<td>10</td>
</tr>
<tr>
<td>Attendance (Theory and Practical)</td>
<td>05</td>
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</tbody>
</table>
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

**Assessment:**
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

**Text Books:**
2. Thomas Hughes, “Programmable Logic Controller”, ISA Publication.

**Reference Books:**
<table>
<thead>
<tr>
<th>Sub code</th>
<th>Subject Name</th>
<th>Teaching Scheme (Hrs)</th>
<th>Credits Assigned</th>
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<tr>
<td>ISE7051</td>
<td>Advanced Embedded Systems</td>
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<td>Internal Assessment (out of 20)</td>
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<td>Term Work</td>
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<td>Pract. and oral</td>
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<tbody>
<tr>
<td>ISE7051</td>
<td>Advanced Embedded systems</td>
<td>5</td>
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</tbody>
</table>

**Course Objectives**
- To make students understand the 32bit processors and higher architectures and configuration.
- Use of Real Time systems and there design in Instrumentation systems.

**Course Outcomes**
- Designing using ARM processors
- Use Real time software for designing instrumentation systems
- Design with configurable hardware systems

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>ARM Processor</strong></td>
<td>06</td>
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<tr>
<td></td>
<td>Introduction to ARM7 &amp; ARM9 Architecture</td>
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<td></td>
<td>ARM 7: ARM-THUMB mode, programming model, instruction set, and programming.</td>
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<tr>
<td>2</td>
<td><strong>LPC2148 architecture</strong></td>
<td>15</td>
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<td></td>
<td>Development tools for High level language-C,Device programming &amp; ISP.</td>
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<td></td>
<td>On-Chip Device peripherals</td>
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<td></td>
<td>RTC programming</td>
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<td></td>
<td>On-chip ADC programming for Signal Sampling</td>
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<td></td>
<td>Watchdog timer</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
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<tbody>
<tr>
<td>Timer programming- Timer / Capture mode</td>
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<tr>
<td>Serial port programming for PC communication</td>
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<tr>
<td>PWM Signal generation</td>
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<tr>
<td>Idle and Power down mode</td>
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<tr>
<td>Interrupt handling</td>
<td></td>
</tr>
<tr>
<td>Universal serial Bus</td>
<td></td>
</tr>
<tr>
<td>Interfacing peripherals</td>
<td></td>
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</tbody>
</table>

**System Design**
- Instrumentation System design with ARM processor
- (Instrumentation Hardware design to be at Block level only)
- Eg: Data acquisition systems
- PID Heater controller etc

**FreeRTOS**
- FreeRTOS design, Task & Scheduler API's, Queue API, Semaphore API
- Software Timer API

**Designing with FreeRTOS**
- LPC2148 port and design using FreeRTOS

**Configurable Hardware**
- Introduction and Architecture of PAL, PLA, CPLD, FPGA.
- Comparison of above devices & application areas, Advantages of above.
- Introduction to development tools, Project development cycle.
- Introduction to Hardware description Languages and its Features.
- Introduction to ASIC, PSOC.

**List of Experiments:**

2 application case studies, & Experiments mentioned in the Unit 2 & 4 above (Use of RTOS is recommended wherever applicable).

A seminar presented by a group of about three students on latest state-of-the-art technologies in Embedded systems: Processor families and trends, Embedded Devices like Digital Camera, Cruise Controller, Mobile phone, Smartcard based Applications & Systems, Point of Sale terminals, DVD Systems, CPLD, FPGA, VHDL, Verilog etc., Various RTOSs like VxWorks, RTLinux, pSOS, Handheld OS- Symbian etc., Selection criteria & development tools For various processors like Cortex-M3, ARM9.

**Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weight age of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
Practical/Oral Examination:
Practical/Oral examination will be based on entire syllabus.

Term Work:
Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments) : 10 Marks
- Laboratory work (programs / journal) : 10 Marks
- Attendance (Theory and Practical) : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Reference Books:
5. FreeRTOS manual
6. LPC2148 Datasheet
<table>
<thead>
<tr>
<th>Sub Code</th>
<th>Subject Name</th>
<th>Teaching Scheme (Hrs)</th>
<th>Credits Assigned</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Practical</td>
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<tr>
<td>ISE7052</td>
<td>Image Processing</td>
<td>4</td>
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<tr>
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<tr>
<td></td>
<td></td>
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<td></td>
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<td>Internal Assessment (out of 20)</td>
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<tr>
<td>ISE7052</td>
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<tr>
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<th>Credits</th>
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<tbody>
<tr>
<td>ISE7052</td>
<td>Image Processing</td>
<td>5</td>
</tr>
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</table>

**Course Objectives**
- The principle of the syllabus is to give an introduction to basic concepts and methodologies for digital image processing. The students are expected to develop a foundation that can be used as the basis for further study and research in this field.
- The syllabus gives great emphasis on basic principles as well as more advanced techniques for image enhancement, segmentation, morphological operations etc.

**Course Outcomes**
- Student will be able to understand the basic concepts and methodologies for digital image processing.
- Students will be able to study and program advanced techniques for image enhancement, segmentation, morphological operations etc.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td><strong>Introduction</strong>: Definition of image, generation of image, steps in image processing, elements of digital image processing systems, image enhancements, restoration and analysis. <strong>Digital Image Fundamentals</strong>: Elements of visible perception, image model, sampling and quantization, relationships between pixels, imaging geometry.</td>
<td>8</td>
</tr>
</tbody>
</table>

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2 **Image Transforms:** Introduction to D.F.T., 2-D.F.T., F.F.T., other separable image transforms (walsh, hadamard, discrete cosine, haar, slant, KL)

3 **Image Enhancements:** Point operations, histogram modeling, spatial filtering-smoothing, sharpening, low pass, high pass, homomorphic filtering.


4 **Image Segmentation:** Detection of discontinuities, age linking and boundary detection, thresholding, region oriented segmentation, use of motion in segmentation.

5 **Image Data Compression:** Introduction, pixel coding, predictive techniques (PCM, DPCM, etc), transform coding theory of images, hybrid coding and vector DPCM.

6 **Morphological Image Processing:** Preliminaries, erosion and dilation, opening and closing, the Hit-or-Miss transformation, some morphological algorithms Like thinning, thickening, skeletons

**LIST OF EXPERIMENTS:**

1. Program for 2-D convolution.
2. Image rotation scaling and translation.
3. Program for 2-D correlation.
4. Program for 2-D F.F.T.
5. Program for Discrete cosine transform.
6. Program for K L transform.
7. Program for Histogram equalization & Histogram specification.
8. Program for Mask operation (Spatial filtering).
9. Program for edge detection.
11. Function for determining boundary descriptors, like boundary length and curvature.
12. Program for opening and closing operations.

**Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4
to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective
lecture hours as mentioned in the syllabus.

**Practical/Oral Examination:**
Practical/Oral examination will be based on entire syllabus.

**Term work:**
Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments) : 10 Marks
- Laboratory work (programs / journal) : 10 Marks
- Attendance (Theory and Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of
laboratory work and minimum passing in the term work.

**Assessment:**
Internal Assessment consists of two tests out of which, one should be compulsory class test (on
minimum 02 Modules) and the other is either a class test or assignment on live problems or course
project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to
be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80%
syllabus should be covered in question papers of end semester examination.

**Text Books:**

**Reference Books:**
4. Don Pearson, “Image Processing” (The ESSEX series in Telecommunication and
   Learning, 2nd edition, 1999
<table>
<thead>
<tr>
<th>Sub code</th>
<th>Subject Name</th>
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<tr>
<td></td>
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<td>Theory</td>
<td>Pract.</td>
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<td>ISE7053</td>
<td>Functional Safety</td>
<td>4</td>
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<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Examination Scheme</th>
</tr>
</thead>
</table>
| ISE7053      | Functional safety  | Theory(out of 100) \[
|              |                    | Internal Assessment (out of 20) \[
|              |                    | Test 1 | Test 2 | Avg. | End Exam | Term Work | Pract. and oral | Oral | Total |
| ISE7053      | Functional safety  | 20     | 20     | 20   | 80      | 25        | -              | 25   | 150   |

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<thead>
<tr>
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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ISE7053</td>
<td>Functional Safety</td>
<td>5</td>
</tr>
</tbody>
</table>

**Course Objectives**
To make the students aware of basic concepts of safety instrumented system, standards and risk analysis techniques.

**Course Outcomes**
The students will be able to
- Understand the role of Safety instrumented system in the industry.
- Identify and analyse the hazards,
- Select the Safety integrity level.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td><strong>Safety life cycle</strong>: Standards and safety life cycle, analysis phase, realisation phase, operations phase Allocation of Safety Functions to Protection Layers, Develop Safety Requirements Specifications, SIS Design and Engineering, Installation, Commissioning and Validation, Operations and Maintenance, Modification, De-commissioning.</td>
<td>06</td>
</tr>
</tbody>
</table>
| 4 | **Rules of Probability:**  
Assigning probability to an event, types of events and event combination, combining event probabilities, fault tree analysis, failure rate and probability, simplifications and approximations. | 08 |
| 5 | **Process Hazard Analysis:**  
Consequence analysis: Characterisation of potential events, dispersion, impacts, occupancy considerations, consequence analysis tools. 
Likelihood analysis: estimation and statistical analysis, fault propagation, event tree analysis and fault tree analysis, Quantitative layer of protection analysis: multiple initiating events, estimating initiating event frequencies and IPL failure probabilities | 12 |
| 6 | **Determining the Safety Integrity Level (SIL):**  
Evaluating Risk, Safety Integrity Levels, SIL Determination Method: As Low As Reasonably Practical (ALARP), Risk matrix, Risk Graph, Layers Of Protection Analysis (LOPA) | 08 |

**Theory Examination:**
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

**Practical/Oral Examination:**
Practical/Oral examination will be based on entire syllabus.

**Term Work:**
Term work shall consist of minimum six assignments and two assignments with EXCEL.
The distribution of marks for term work shall be as follows:
- Laboratory work : 10 Marks
- Laboratory work (programs / journal) : 10 Marks
- Attendance : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

**Assessment:**
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Reference Books:

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<td>ISE7054</td>
<td>Process Modeling &amp; Optimization</td>
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<td>Process Modeling &amp; Optimization</td>
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<th>Credits</th>
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<tbody>
<tr>
<td>ISE7054</td>
<td>Process Modeling &amp; Optimization</td>
<td>05</td>
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</tbody>
</table>

**Course Objectives**
- To make students understand the basic approach to the problem of mathematical modeling and identifying the variables by using direct methods.
- To translate a descriptive statement of the design problem into a mathematical statement for optimization.
- To use numerical methods for solving engineering optimization problems.

**Course Outcomes**
- Students will be able to
  - formulate mathematical models of the complex engineering systems.
  - to use an optimization algorithm to solve linear and nonlinear optimization problems.
  - explain the kind of interaction possible with an optimization algorithm.

**Module No.**
- **Mathematical Modeling**
| 2 | **Process Identification**  
Direct Methods: Time-Domain “Eyeball” Fitting of Step test data,  
Direct Sine-Wave Testing, Pulse Testing, Step Testing, ATV Identification, Least-Squares Method, State Estimator. | 06 |
|---|---|
| 3. | **Introduction to Optimization:**  
Definition and meaning of optimization, need of optimization, conventional versus optimum design process, optimization problem formulation – statement of an optimization problem, terminology, design vector, objective function, design constraints, constraint surface,  
Iteration, convergence, classification of optimization problem, engineering applications of optimization. | 06 |
| 4. | **Classical Optimization Techniques:**  
Fundamental concepts- local and global minima, local and global maxima, quadratic form, necessary and sufficient condition of single and multivariable optimization with no constraints, multivariable optimization with equality and inequality constraints(Kuhn-Tucker condition), Lagrange Theorem. | 10 |
| 5. | **Linear Programming :**  
Definition of linear programming problem (LPP), standard form of LPP, terminology, basic concepts, Simplex Algorithm and flowchart, simplex method, two-phase simplex method, Duality in LPP | 09 |
| 6. | **Numerical Methods for Unconstrained Optimum Design:**  
General algorithm for unconstrained minimization methods, rate of convergence, unimodal and multimodal function ,reduction of a single variable, one dimensional minimization methods- Equal Interval method, Golden section search method, Polynomial Interpolation : Quadratic Interpolation method, Cubic Interpolation method,  
Gradient of a function, properties of gradient vector, Steepest Descent, Conjugate gradient (Fletcher-Reeves). | 10 |

**Assignments:**
Each student shall do at least Two assignments on Module No. 1, One assignment on Module No. 2, Two Assignments on Module No. 3 and Two assignments on Module No. 4, 5 & 6 each.

**Theory Examination:**
1. Question paper will consist of total 6 questions of 20 marks each.  
2. Only 4 questions need to be solved.  
3. Q.1 will be compulsory and based on the entire syllabus.  
4. Remaining questions will be mixed in nature.  
5. In question paper, weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

**Oral Examination:**
Oral examination will be based on entire subject.

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**Term work:**
Term work consists of minimum ten assignments.
The distribution of the term work shall be as follows:

- Laboratory work (Assignments/Experiments): 10 Marks
- Laboratory work (Journal): 10 Marks
- Attendance (Theory and Practical): 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

**Assessment:**
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

**Text Books:**


**Reference Books:**

### Subject Code  
**ISE7055**  
**Subject Name**  
Wireless Communication  
**Credits**  
5

### Course Objectives  
- To make students understand concept of Wireless Communication in real time process control application.

### Course Outcomes  
The students will be able to  
- Basics of Wireless Communication Systems  
- Understands Wireless Transceivers and Advanced Transceivers  
- Understands Wireless Application Protocol  
- Understands Different Wireless trends in Industry

### Module  
**Introduction to Wireless Communication:**  
History, Types of services: Broadcast, paging, cellular Telephony, cordless telephony, Wireless LAN (WLAN), Ad Hoc Network, Personal Area Network (PAN), Wireless Sensors networks  
Bandwidth concept, Technical challenges of Wireless Communication: Multipath propagation, spectrum limitations  
Present scenario in Wireless Communication Systems  
**Hrs.**  
10

**Wireless Transceivers:**  
Quadrature Phase shift keying, differential quadrature phase shift keying, offset quadrature phase shift keying, minimum phase shift keying, Gaussian minimum shift keying, power spectrum and error performance in fading channels.  
**Hrs.**  
08

**Advanced Transceivers:**  
Spread spectrum systems TDMA, SDMA, CDMA, FDMA principle, power control, effects of multipath propagation on CDMA, OFDM, DSSS and FHSS.  
**Hrs.**  
06

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**University of Mumbai, Instrumentation Engineering, Rev 2012-13  33**
| 4 | **Wireless Application Protocol (WAP):**  
|---|---|---|
| 5 | **Application of Wireless Communication:**  
  Bluetooth, Ultra Wide Band, Zigbee, WiFi, Introduction to 3G & 4G | 06 |
| 6 | **WirelessHART:**  
  WirelessIntroduction  
  WirelessHART Security Overview  
  WirelessHART Adaptor  
  WirelessHART Gateway  
  Co-Existence of WirelessHART with other Wireless Technologies  
  Control with WirelessHART  
  System redundancy with WirelessHART  
  Peer-to-Peer Communication with WirelessHART  
  Introduction to Wireless Foundation Fieldbus | 10 |

**Theory Examination:**
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

**Practical/Oral Examination:**
Practical/Oral examination will be based on entire syllabus.

**Term Work:**
Term work shall consist of minimum eight Assignments based on above topics.
The distribution of marks for term work shall be as follows:
- Laboratory work (Assignments/Experiments) : 10 Marks
- Laboratory work (Journal) : 10 Marks
- Attendance (Theory and Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

**Assessment:**
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**University of Mumbai, Instrumentation Engineering, Rev 2012-13**  34
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

**Text Books:**

4. [http://www.hartcomm.org](http://www.hartcomm.org)

**Reference Books:**

### Course Objectives
- To equip the students with the basic knowledge of discretization.
- To study the stability analysis of digital control system.
- To study the canonical forms of digital control systems.
- To determine steady state performance of Digital control systems.
- To design the controller and observer for digital control systems.
- To study PID discrete controller.

### Course Outcomes
The students will be able to:
- Understand mathematical models of linear discrete-time control systems using transfer functions and state-space models.
- Analyze transient and steady-state behaviours of linear discrete-time control systems.
- Determine whether performance of linear discrete-time control systems meet specified design criteria.
- Design controllers and observers for linear discrete-time control systems so that their performance meet specified design criteria.
- Design PID controllers.

### Topics

<table>
<thead>
<tr>
<th>Contents</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>01</strong> Introduction Block diagram of Digital Control System, Advantages &amp; limitations of Digital Control System, comparison of continuous data &amp; discrete data control system, Examples of digital control system, data conversion and quantization, sampling period considerations, sampling as impulse modulation, sampled spectra &amp; aliasing, Reconstruction of analog signals, zero order hold, first order hold.</td>
<td>12</td>
</tr>
</tbody>
</table>
| 02 | **Representation of digital control system**  
Linear difference equations, pulse transfer function, input output model, examples of first order continuous and discrete time systems, Signal flow graph applied to digital control systems. |
|---|---|
| 03 | **Stability of digital control system in z-domain and Time domain analysis**  
Jury’s method, R.H. criteria, Comparison of time response of continuous data and digital control system, steady state analysis of digital control system, Effect of sampling period on transient response characteristics. |
| 04 | **State space analysis**  
Discrete time state equations in standard canonical forms, similarity transformation, state transition matrix, solution of discrete time state equation, Discretization of continuous state space model &its solution. |
| 05 | **Pole placement and observer designs**  
Concept of reachability, Controllability, Constructability & Observability, Design of controller via Pole placement method, dead beat controller design, concept of duality, state observer design, Concept of Multi rate output feedback (MROF) based state estimation. |
| 06 | **Transfer Function Approach to Controller Design**  
Control Structures, Internal Stability and Realizability, Internal Model Principle and System Type, Well Behaved Signals, Solving Aryabhatta’s Identity.  

**List of Laboratory Experiments:**
1. To determine response of zero order hold and first order hold using Simulink of MATLAB or any other suitable software.
2. Mapping from S-plane to Z-plane analytically and verification using MATLAB or any other suitable software.
3. Discretization of continuous data system using i) Step invariance method, ii) Impulse invariance method, and iii) Bilinear transformations, analytically and verification using MATLAB or any other suitable software.
4. To represent given system in different canonical forms, analytically and verification using MATLAB or any other suitable software.
5. To determine pulse transfer function of a given system analytically and its verification using MATLAB or any other suitable software.
6. Determination of state transition matrix analytically and its verification using MATLAB or any other suitable software.
7. To check controllability and observability of a given system analytically and verify the result using MATLAB or any other software.
8. To plot pole-zero map of a discrete system and comment on response and stability.
9. To design the controller using  
   i. Transform method
ii. Ackerman’s Formula

Analytically and verification using MATLAB or any other suitable software.

10. To design an observer using .
   i. Transform Method
   ii. Ackerman’s Method

Analytically and verification using MATLAB or any other suitable software.

11. To design deadbeat controller and observer using any method analytically and verification using MATLAB or any other suitable software.

**Note:** The above list is only indicative of possible experiments. Faculty may choose other experiments as well. Care should be taken that the entire syllabus is uniformly covered by the experiments.

Note: Case study 1: Developing a state space model of any physical system available in laboratory (Flow loop, pressure loop, level loop etc.) and designing the controller using pole placement method (state space method) and implement the same using simulink of MATLAB or any other suitable software.

Case study 2: Developing a pulse transfer function of any physical system available in laboratory (Flow loop, pressure loop, level loop etc.) and designing the controller using transfer function approach (eg. 2-DOF or IMC controller) and implement the same using simulink of MATLAB or any other suitable software.

**Theory Examination:**
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

**Practical/Oral Examination:**
Practical/Oral examination will be based on entire syllabus.

**Term work**
Term work consists of minimum eight experiments, one case study. The distribution of the term work shall be as follows,

| Laboratory work (Experiments) | 10 Marks |
| Laboratory work (programs / journal) | 10 Marks |
| Attendance (Theory and Practical) | 05 Marks |

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

*University of Mumbai, Instrumentation Engineering, Rev 2012-13  38*
Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on problems.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:


Reference Books:

<table>
<thead>
<tr>
<th>Sub code</th>
<th>Subject Name</th>
<th>Teaching Scheme (Hrs)</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISC 802</td>
<td>Instrumentation Project Documentation &amp; Execution</td>
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<td>2</td>
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<tr>
<th>Sub code</th>
<th>Subject Name</th>
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<td>Internal Assessment (out of 20)</td>
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<tr>
<td>ISC 802</td>
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<td>20</td>
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<tbody>
<tr>
<td>ISC 802</td>
<td>Instrumentation Project Documentation &amp; Execution</td>
<td>5</td>
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</table>

**Course Objectives**
- To provide knowledge of Instrumentation Project & Detailed Engineering techniques in the EPC Consultancy.
- The course aims to explain Project Deliverables and Engineering activities of Project Documentation.

**Course Outcomes**
- Design & Develop Basic & Detailed Engineering Project Deliverables.
- Understand Types of Project Executed in I & C Projects.
- Develop skills to Execute and carry different activities in process industry.
- Understand Procedures, Guidelines and Thumb Rules for performing Precommissioning activities.
- Overall Development of the students by Hands on working Experience.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>The Project</strong>: Introduction, predictability, structure, flow and deliverables, Project Planning and Scheduling – project scheduling estimating, configuration management</td>
<td>08</td>
</tr>
<tr>
<td>2</td>
<td><strong>The Project Team</strong>: Customer, designer and constructor</td>
<td>02</td>
</tr>
<tr>
<td>3</td>
<td><strong>Standards used in instrumentation project</strong>: ISA, ANSI, &amp; ASTM, ASME, NFPA, NEMA. <strong>Project Documents</strong>- Need for Engineering Documents, General Guidelines for Development of Documents, project stage, purpose, scope, contents, references for document, team of creation and users. Major Project Documents: 1) Process Flow Diagram-</td>
<td>18</td>
</tr>
</tbody>
</table>
2) Piping and Instrumentation diagrams (P&ID) - practical applications.
3) Instrument Index Sheet
4) Instrument specifications sheet - for temperature, pressure, level, flow
   instruments and control valves.
5) Instrument Location Plan
6) Cable and Tray Routing
7) Cable Schedule
8) JB Schedule
9) Utility requirement
10) Air header schedule
11) Instrument Hook-up diagrams - for control valve, transmitters (DP in
    liquid service, dry gas service,) Thermocouple, Temperature switch
    line mounted, flow transmitter, typical level switch, typical
    instrument air supply, connections for air supply and output. etc.
12) BOM for erection
13) Loop diagrams - pneumatic, electronic and digital data types.
14) Logic diagrams, SAMA Standard

| 4 | **Systems Integration:** Division of labour, control logic specification, HMI
   specification Development, System Architecture Design, Network single line
   diagram generation, Other tasks like control system cabinet design, I/O
   address assignment (Partitioning)-Hardware & software address, System
   testing. |
|---|---|

| 5 | **Procurement, Installation and Commissioning:**
   **Procurement:** Engineering Procurement procedure, PO format, preparation
   of tender documents, bids, technical bid evaluation.
   **Inspection:** Need for Inspection, Documents for Inspection,
   General Inspection Guidelines, Factory acceptance test (FAT) &
   Site acceptance test (SAT), check lists.
   **Installation of instruments:** Installation standards, installation of
   instrument junction box, earthing system, cable laying (cable trays, cable
   types, cable glands), tubing, instrument installation guidelines.
   **Commissioning:** Pre-commissioning Procedures, check out procedure of
   control valve, DP transmitter etc. calibration, testing of instruments,
   operation and maintenance manual, commissioning Procedures. Onsite
   training. |
|---|---|

| 6 | Advantages of using software packages for documentation. Overview of
   documentation software packages used in industry like SPI -Intools. |
|---|---|

**Suggested List of Laboratory Experiments:**

4. Study & Development of Instrumentation Index.
5. Study ISA specification forms & Development of Instrument Specifications.
6. Study & Development of Instrumentation Location plan.
7. Study & Development of Cable Tray Layout.
8. Study & Development of Sample Hook up drawing & Preparation of BOM.

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9. Study & Development of Detailed Engineering schedules. (Project schedule / Cable schedule / JB schedule / AH schedule)
10. Study & Development of Electronic Loop wiring Diagrams.
12. Study & Perform pre-commissioning activities. (Hydro Test / Loop checking / Trouble shooting etc)
13. Survey of Instrumentation softwares & Study different features of SPI INTools.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Oral Examination: 25 Marks
Oral examination will be based on entire subject, Lab work & Consultants visit if any.

Term Work:

Term work shall consist of Laboratory work which includes Minimum study of eight assignments/Creation of Documents
Other task:(Optional) Visit to any one Engineering consultants office /organizations to understand their Working Environment & submission of Report.
The distribution of marks for term work shall be as follows:
Laboratory work (Assignments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance (Theory and Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on problems.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.
Text Books:


Useful References in PDF form:

Specification forms- ISA-20-1981- ISA Publication
Piping and Instrumentation Diagram Documentation Criteria- Process Industry Practices
Instrumentation Design Criteria-ONGC, Mumbai
Commissioning Procedures -ONGC, Mumbai
### Course Objectives

To make students to understand:
- Control Valve Sizing concepts and its usual terms for applications like liquid, gas, vapour and flashing fluids.
- Control room and Control Panel details
- The process of Electronic product design

### Course Outcomes

The students will be able to:
- Design and Analyse CV Sizing
- Identify various Control panels and Control Room details
- tDesign of Electronic product.

### Module Topics and Hrs.

1. **Design of Transducers:**
   - An overview of static and dynamic performance characteristics of instruments. Selection criteria for flow, temperature transducers. Design considerations for transducers such as thermocouple, RTD, orifice plates, Rotameter. Calibration and installation procedure for thermocouple and RTD
   - Hrs.: 05

2. **Design of Control Valve:**
   - Hrs.: 16

3. **Control Panel Design:**
   - Hrs.: 11

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### Electronic product design:
- System Engineering, ergonomics, phases involved in electronic product design.

### Enclosure Design:
- Packing and enclosures design guidelines, Grounding and shielding, front panel and cabinet design of an electronic product.

### Reliability engineering:
- Reliability concepts, causes of failures, bathtub curve, Quality and reliability, MTTF, MTBF, and MTTR. Availability and Maintainability. Redundancy and redundant systems.

### Control Room Design:
- Layout and environment.

### List of Assignments:
1. Assignment on design of transducer
2. Assignment on valve sizing and examples on valve sizing for liquid services
3. Assignment: examples on valve sizing for gas and vapor services
4. Assignment: examples on valve sizing for flashing and mixed flow services
5. Assignment: examples on valve sizing for Noise and Cavitations
6. Assignment: examples on actuator sizing
7. Assignment on control panel design
8. Assignment on control room design, reliability and electronic product design
9. Assignment on electronic product design

### Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

### Practical/Oral Examination:
Oral examination will be based on entire syllabus.

### Term Work:
Term work shall consist of minimum eight assignments
The distribution of marks for term work shall be as follows:
- Laboratory work (Assignments): 10 Marks
- Laboratory work (programs / journal): 10 Marks
- Attendance (Theory and Practical): 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on problems.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

Reference Books:
2. Les Driskell, “Control valve sizing”, ISA.
<table>
<thead>
<tr>
<th>Sub code</th>
<th>Subject Name</th>
<th>Teaching Scheme (Hrs)</th>
<th>Credits Assigned</th>
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</thead>
<tbody>
<tr>
<td>ISE8041</td>
<td>Nuclear Instrumentation</td>
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<th>Subject code</th>
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<td></td>
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<td>Theory(out of 100)</td>
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<tr>
<td></td>
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<td>Internal Assessment (out of 20)</td>
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<td>End Exam  Exam duration (in Hrs)</td>
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<td>Term Work  Oral  Total</td>
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<tr>
<td>ISE8041</td>
<td>Nuclear Instrumentation</td>
<td>20 20 20 80 03 25 25 150</td>
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<tr>
<td>ISE8041</td>
<td>Nuclear Instrumentation</td>
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</table>

**Course Objectives**
- To introduce the basic concept of radioactivity, properties of alpha, beta and gamma rays
- To study various radiation detectors, detector classification
- To study the electronics and counting systems
- To study applications of nuclear instrumentation in medicines, Industry and in Agriculture.

**Course Outcomes**
- The students get well versed with construction and working of various radiation detectors.
- Students also get thorough knowledge of electronics and counting systems used in nuclear instrumentation.
- Students get detailed information about applications of nuclear instrumentation in medicine, industry etc.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Radioactivity</strong>: General properties of Nucleus, Radioactivity, Nature of Nuclear Radiation's, Properties of Alpha, Beta and Gamma rays, Natural and artificial radioactivity. Radioactivity Laws, Half life period, radioactive series, Isotopes and Isobars, Various effects- photoelectric, Compton scattering and pair production, stopping power and range of charged nuclear particles.</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td><strong>Radiation Detectors</strong>: Techniques for radiation detection, Detectors for Alpha, beta and gamma rays, Detector classification, Gas filled detectors - volt ampere characteristics, Ionization chamber, Proportional counter, Geiger Muller counter, Designing features, Scintillation detectors, Photomultiplier tube, dark currents, pulse resolving power, efficiency of detection, Solid state detectors (Lithium ion</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td><strong>Electronics and Counting systems</strong>: Pre-amp, shaping amplifiers, Discriminators, Scalars and count rate meters, Pulse shaping, peak stretchers, photon counting system block diagram, single channel analyzer SCA (pulse height analyzer - PHA), Coincidence detection</td>
<td>6</td>
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<tr>
<td>4</td>
<td><strong>Nuclear Spectroscopy systems</strong>: Factors influencing resolution of gamma energy spectrum, Energy resolution in radiation detectors, Multichannel analyzers (MCA), Role of Nuclear ADC's – performance parameters.</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td><strong>Applications in Industry</strong>: Basic Nuclear Instrumentation system – block diagram, Personal monitors like Thermo Luminescence Detectors (TLD). Dosimeters, Tele-detectors. Nuclear Instrumentation for power reactor. Nuclear Instrumentation for Toxic fluid tank level measurement, weighing, thickness gauges, Agriculture applications like food irradiation, Underground Piping Leak detection, water content measurement etc.</td>
<td>6</td>
</tr>
</tbody>
</table>

**List of Laboratory Experiments:**

1. To study preamplifiers for nuclear pulse processing.
2. To study pulse shaping circuit for nuclear pulse processing
3. To study discriminators for nuclear pulse processing
4. Study of GM Counter Pulses
   
   Purpose: The purpose of this experiment is to familiarize oneself with typical output pulses of a GM counting system. The fact that the pulse height increases with increasing voltage through different regions (ionization, proportionality etc) and is roughly constant in the Geiger region including that pulse height is the same regardless of the energy or character of incident radiation

5. Study of the V-I characteristics of a GM Counting System.
   
   Purpose: To study the variations of count rate with applied voltage and thereby determine the plateau region, operating voltage and slope of plateau.
6. To study the Gamma Ray Spectrometer based on SCA.

   Purpose: The purpose is to understand the functioning and working of Spectrometer.

7. To obtain the spectrum of Gamma emitting isotope Cs 137 by using scintillator spectrometer.
8. To obtain the spectrum of Gamma emitting isotope Co 60 by using scintillator spectrometer.

9. To study the energy calibration of Spectrometer and analysis of the energy of unknown Gamma source.
Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Oral Examination:
Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum three experiments (from the list given above) and ten assignments based on entire subject.
The distribution of marks for term work shall be as follows:
Laboratory work (Assignments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance (Theory and Practical) : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

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</thead>
<tbody>
<tr>
<td>ISE8042</td>
<td>Power Plant Instrumentation</td>
<td>4</td>
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<td></td>
<td></td>
<td>Theory(out of 100)</td>
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<tr>
<td>ISE8042</td>
<td>Power Plant Instrumentation</td>
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<tr>
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<tbody>
<tr>
<td>ISE8042</td>
<td>Power Plant Instrumentation</td>
<td>5</td>
</tr>
</tbody>
</table>

**Course Objectives**
- To create awareness of energy resources and its scenario in India.
- To study the concept of power generation using various resources.
- To study the role of Instrumentation in power plants.
- To study and compare various power plants for optimal performance.

**Course Outcomes**
- The students get well versed with all power generation plants.
- Students also get thorough knowledge of Instrumentation involved in power plants.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction:</strong> Energy sources, their availability, worldwide energy production, energy scenario of India. Introduction to Power generation, load curve, load factor. Classification of energy generation resources.</td>
<td>04</td>
</tr>
<tr>
<td>2</td>
<td><strong>Thermal Power Plant</strong>- Method of power generation, layout and energy conversion process. Types of Turbines &amp; their control. Types of Boilers and their control. Types of Generators and their control, Condensers. Types of Pumps and Fans, variable speed pumps and fans, Material handling system, study of all loops-water, steam, fuel etc. Schematics of Gas turbine and Diesel power plant. Application of DCS in power plants.</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td><strong>Hydroelectric Power Plant</strong>- Site selection, Hydrology, Estimation electric power to be developed, classification of Hydropower plants. Types of Turbines for hydroelectric power plant, pumped storage plants, storage reservoir plants.</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>Course Title</td>
<td>Credits</td>
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<tr>
<td>4</td>
<td><strong>Nuclear Power Plant</strong> – Concept of energy generation from nuclear fission, control of chain reaction. Schematics of Nuclear power plant, types of reactors, reactor control, safety measures.</td>
<td>08</td>
</tr>
<tr>
<td>6</td>
<td>Comparison of different types of power plant: thermal power plant, hydro electric power plant, wind, solar, nuclear power plant on the basis of: Performance, efficiency, site selection, Economics-capital and running, safety. Introduction to Hybrid Power Generation concept.</td>
<td>04</td>
</tr>
</tbody>
</table>

**Theory Examination:**
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

**Oral Examination:**
Oral examination will be based on industrial visit and entire subject.

**Term Work:**
Term work consists of minimum eight Tutorials/assignments based on entire subject and industrial visit report.
The distribution of marks for term work shall be as follows:
Laboratory work (Tutorials/Journal/Assignments) : 20 Marks
Attendance : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

**Assessment:**
Internal Assessment consists of two tests out of which; one should be compulsory class test (on
minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

Reference Books:
1. “Power Plant Engg.”, Domkundwar
<table>
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<tbody>
<tr>
<td>ISE8043</td>
<td>Optimal Control Theory</td>
<td>4</td>
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<tr>
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<tbody>
<tr>
<td>ISE8043</td>
<td>Elective-I : Optimal Control Theory</td>
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<thead>
<tr>
<th>Examination Scheme</th>
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<tbody>
<tr>
<td>Theory(out of 100)</td>
</tr>
<tr>
<td>Internal Assessment (out of 20)</td>
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<tr>
<td>Test 1</td>
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<td>20</td>
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<tbody>
<tr>
<td>ISE8043</td>
<td>Elective-I : Optimal Control Theory</td>
<td>5</td>
</tr>
</tbody>
</table>

### Course Objectives
- To make students understand the optimal control problems their types and how to solve them by calculus of variation and dynamic programming approaches.
- To make student to understand the linear regulator and tracking systems, discrete time optimal control systems.

### Course Outcomes
- The students will be able to
  - Identify various optimal control problems with performance measure with minimum time, minimum fuel, minimum energy, terminal cost and general problems.
  - Understand principle of calculus of variation, optimality, dynamic programming and their applications.
  - Make comparative study of problems based on calculus of variation, linear regulator, tracking and dynamic programming problems.
  - Understand applications of these methods for solving various optimal control problems.

### Module

<table>
<thead>
<tr>
<th>Topics</th>
<th>Hrs.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction</strong>: Formulation of optimal control problem, Performance measure, selecting a performance measure.</td>
</tr>
</tbody>
</table>
| 2      | **Calculus of variation I**
Extremum of functional of single function: fixed and free end point problems, Extremum of functional of several independent function: fixed and free end point problems. | 10    |
Assignments:

Each student shall do at least One assignment on Module No. 1, Two assignments on Module Nos. 2, 3, 4 and 5 each, Three Assignments on Module No. 6. For all assignments, use MATLAB or Scilab or MathCAD simulation software.

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Practical/Oral Examination:
Practical/Oral examination will be based on entire syllabus.

Term Work:
Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance (Theory and Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on
minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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<tr>
<td>ISE8044</td>
<td>Nano Technology</td>
<td>3</td>
<td>2</td>
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<tr>
<td>ISE8044</td>
<td>Nano Technology</td>
<td>5</td>
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</table>

Course Objectives
- To explain students to basic concepts of nanodevices and various sensors.
- To provide knowledge about the applications of nanotechnology

Course Outcomes
The students will be able to
- Understand the working of MEMS and NEMS
- Understand the applications of nanosensors and detectors

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>SEMICONDUCTOR NANODEVICES:</strong></td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td><strong>MEMS AND NEMS:</strong></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Development of micro electronics - Region of Nanostructures - methods and limits on microminiaturization in semiconductors- micro electro mechanical system. Silicon micromachining- semiconductors and insulator Microsystems fabrication techniques - Silicon MEMS fabrication technology - Single crystal reactive etching and metallization process.</td>
<td></td>
</tr>
</tbody>
</table>
### Non-silicon MEMS and fabrication techniques - SIC MEMS - Biomedical-MEMS techniques - Integration of microsystems with electronics – RF MEMS – Applications.

Polymers in Microsystems - Packaging of MEMS devices by anodic/fusion bonding - Pressure sensors and packaging - MEMS performance and evaluation.

Nano electro mechanical systems - fabrication and process techniques - Integration of nanosystems and devices - applications and future challenges.

### NANOSENSORS, DETECTORS AND THEIR APPLICATIONS:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Category</th>
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<tbody>
<tr>
<td>Gas sensor materials: Criteria for the choice of materials, Experimental aspects – materials, properties, measurement of gas sensing property, sensitivity; Discussion of sensors for various gases, Gas sensors based on semiconductor devices.</td>
<td>06</td>
</tr>
<tr>
<td>Biosensors: Principles- DNA based biosensors – Protein based biosensors – materials for biosensor applications- fabrication of biosensors - future potential.</td>
<td>04</td>
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</table>

### Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

### Practical/Oral Examination:

Practical/Oral examination will be based on entire syllabus.

### Term Work:

Term work shall consist of minimum eight experiments/assignments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments) : 10 Marks
- Laboratory work (programs / journal) : 10 Marks
- Attendance (Theory and Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Assessment:
Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
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<tr>
<td>ISE8045</td>
<td>Fiber Optic Instrumentation</td>
<td>4</td>
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<tr>
<td></td>
<td></td>
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<td>ISE8045</td>
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<td>ISE8045</td>
<td>Fiber Optic Instrumentation</td>
<td>5</td>
</tr>
</tbody>
</table>

Course Objectives
- To expose the students to the basic concepts of optical fibres and their properties.
- To provide adequate knowledge about the Industrial applications of optical fibres.

Course Outcomes
The students will be able to:
- Identify various sensors, Fiber optic and its specifications.
- Understand principle of working of Fiber Optic used to measure Temperature, Displacement, Level, and various miscellaneous other sensors.
- Understand applications of Fiber Optics in industry.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Optical Fiber and Their properties:</strong> Ray theory, wave guiding principles, Theory of optical wave propagation, Types and classification of optical fibers, optical fiber mode, single mode fiber, special fiber, fiber materials, fiber fabrication, transmission characteristics of fiber, absorption losses, scattering losses, dispersion, polarisation, non-linear phenomena</td>
<td>08</td>
</tr>
<tr>
<td>2</td>
<td><strong>Optical Sources and Detectors, Power Launching and Coupling:</strong> Laser theory, Laser diodes, LED, PN diode, Pin diode, avalanche diode, solid, liquid, gas and semiconductor laser their characteristics modulation circuits, optical detection principles, quantum efficiency and detector noise, Source to fiber power launching, fiber alignment and fiber to fiber joints, splices, connectors, coupling losses, lensing schemes for coupling improvement, LED coupling to single mode fiber.</td>
<td>12</td>
</tr>
</tbody>
</table>
### Optical Fiber Measurements:
Measurement of attenuation, dispersion, refractive index profile of fiber and cut off wavelength, numerical aperture, OTDR, Measurement of flow, pressure, Temperature, displacement, acceleration and fluid level vibration measurement.

### Fiber Optic Sensing Principles and Techniques:
Classification and principle of fiber optic sensors, fiber grating and fiber Bragg grating technology and distributed optical fiber sensing.

### Optical Amplification and Integrated Optics:
Beam splitter, directional coupler, opto isolators, multi mode interference coupler(MMIC) optical modulators, fiber modulator optical amplifiers, optical switches, frequency translators, optoelectronic integration.

### Holography and Laser instruments in medical application and Remote Sensing:

<table>
<thead>
<tr>
<th>List of Experiments:</th>
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</thead>
<tbody>
<tr>
<td>1. Study of Fiber optic communication set-up.</td>
</tr>
<tr>
<td>2. To measure numerical aperture of an optical fiber.</td>
</tr>
<tr>
<td>3. To study characteristic curves of optical sources and detectors.</td>
</tr>
<tr>
<td>4. To plot spectral response characteristics of photodiode</td>
</tr>
<tr>
<td>5. Displacement measurement by fiber optic sensor.</td>
</tr>
<tr>
<td>6. Characteristics of opto-coupler</td>
</tr>
<tr>
<td>7. To study attenuation losses in optical fiber.</td>
</tr>
<tr>
<td>8. To study dispersion losses in optical fiber.</td>
</tr>
<tr>
<td>9. To study different splicing techniques.</td>
</tr>
<tr>
<td>10. Design of an optical fiber sensor.</td>
</tr>
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### Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 question need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

### Oral Examination:
Oral examination will be based on entire syllabus.

University of Mumbai, Instrumentation Engineering, Rev 2012-13  60
**Term Work:**
Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments) : 10 Marks
- Laboratory work (programs / journal) : 10 Marks
- Attendance (Theory and Practical) : 05 Marks

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Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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**Text Books:**


**Recommended Books:**