UNIVERSITY OF MUMBAI

Bachelor of Engineering

Instrumentation Engineering (Third Year – Sem. V & VI),
Revised course
(REV-2012) from Academic Year 2014-15, Under
FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)
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
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能力 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
## Semester V

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract./Tut.</td>
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<tr>
<td>ISC501</td>
<td>Signals and Systems</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>ISC502</td>
<td>Applications of Microcontroller -I</td>
<td>4</td>
<td>2</td>
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<tr>
<td>ISC503</td>
<td>Control System Design</td>
<td>4</td>
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<tr>
<td>ISC504</td>
<td>Signal Conditioning Circuit Design</td>
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<td>Control system components</td>
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<td>Business Communication and Ethics</td>
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<td>Internal Assessment</td>
<td>End Sem exam</td>
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<td>Test 1</td>
<td>Test 2</td>
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<td>ISC502</td>
<td>Applications of Microcontroller -I</td>
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<td>Control System Design</td>
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<td>Control system components</td>
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+ Includes both Practical and Oral examination,
* Theory for entire class to be conducted

University of Mumbai, Instrumentation Engineering, Rev 2012-13  3
## Semester VI

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<tr>
<th>Subject Code</th>
<th>Subject Name</th>
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<td>Power Electronics and Drives</td>
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<td>Digital Signal Processing</td>
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<td>ISC604</td>
<td>Applications of Microcontroller -II</td>
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<td>ISC605</td>
<td>Industrial Data Communication</td>
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<td>ISC606</td>
<td>Analytical Instrumentation</td>
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<td>ISC601</td>
<td>Process Instrumentation Systems</td>
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<td>ISC602</td>
<td>Power Electronics and Drives</td>
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<td>ISC603</td>
<td>Digital Signal Processing</td>
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<tr>
<td>ISC604</td>
<td>Applications of Microcontroller -II</td>
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<td>ISC605</td>
<td>Industrial Data Communication</td>
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<td>ISC606</td>
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* Includes both Practical and Oral examination
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<th>Subject Name</th>
<th>Teaching Scheme (Hrs.)</th>
<th>Credits Assigned</th>
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<tbody>
<tr>
<td>ISC501</td>
<td>Signals and Systems</td>
<td>Theory 4</td>
<td>Practical 2</td>
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<th>Subject Code</th>
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<th>Examination Scheme</th>
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<tr>
<td></td>
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<td>Internal assessment</td>
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<td>Test 1 20 80</td>
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<td></td>
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<td>Test 2 20</td>
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<td>Practical &amp; Oral --</td>
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<th>Credits</th>
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<tbody>
<tr>
<td>ISC501</td>
<td>Signals and System</td>
<td>5</td>
</tr>
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</table>

**Course Objectives**

- To introduce students to the idea of signal and system analysis and characterization in time and frequency domain.
- To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

**Course Outcomes**

- Students will be able to understand significance of signals and systems in the time and frequency domains.
- Students will be able to interpret and analyze signal and report results.
- Students will be able to evaluate the time and frequency response of continuous and discrete time, system which is useful in understanding behavior of communication and control systems.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction:</strong></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Definition of signal, Singular Functions,</td>
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<tr>
<td></td>
<td>Basic Operations on signal such as:</td>
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<tr>
<td></td>
<td>Addition, Multiplication, Time Scaling,</td>
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<tr>
<td></td>
<td>Time Shifting, Folding, and Amplitude</td>
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<tr>
<td></td>
<td>Scaling.</td>
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<td></td>
<td>Classification: C.T. D.T, Periodic,</td>
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<tr>
<td></td>
<td>aperiodic, / non-periodic, Even/Odd,</td>
<td></td>
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<tr>
<td></td>
<td>Energy/ Power, causal and anticausal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>signals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classification of System: Static and</td>
<td></td>
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<tr>
<td></td>
<td>dynamic, time invariant and time variant,</td>
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<tr>
<td></td>
<td>Linear and Non linear, Causal and</td>
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<td></td>
<td>Non causal stable and unstable invertible</td>
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<tr>
<td></td>
<td>and non invertible.</td>
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<td>2</td>
<td><strong>Linear Time Invariant System:</strong></td>
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<tr>
<td></td>
<td>Linear differential equations, Impulse</td>
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<tr>
<td></td>
<td>response Representation of signals by a</td>
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<tr>
<td></td>
<td>continuum of impulses.</td>
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</table>
**Convolution for continues time and discrete time (Linear and Circular)**
Properties of LTI System.

<table>
<thead>
<tr>
<th>3</th>
<th><strong>Fourier Series</strong></th>
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<tbody>
<tr>
<td><strong>Orthogonal functions, definitions, Approximation, Co-efficient calculation on the basis of min. Mean square error.</strong></td>
<td></td>
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<tr>
<td><strong>Representation of Fourier series in terms of trigonometric, exponential, complex. Gibbs phenomenon.</strong></td>
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<table>
<thead>
<tr>
<th>4</th>
<th><strong>Fourier Transform</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Continuous and Discrete time Fourier transform Properties. Linearity, time shifting, time reversal, frequency shifting, Scaling, Convolution in time domain, diff. in time domain. Differentiation in freq. domain parsevals relation. Relationship between Z, Laplace and Fourier transform.</strong></td>
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</tbody>
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<tr>
<th>5</th>
<th><strong>Laplace Transform:</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Definition ROC concept, Properties, Inverse LT Transient and steady state response of LTI system. Stability &amp; Causality of system.</strong></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>6</th>
<th><strong>Z-Transform:</strong></th>
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</thead>
</table>

**List of Tutorials / Experiments:**

1. Difference between continuous time and discrete time signals, classification, problems on Signal classification.
2. Difference between continuous time and discrete time signals, classification, problems on Systems classification.
3. Problems on Basic Operations on signals.
5. Problems on convolution Integral, convolution sum and correlation.
7. Concept of Z-Transform (Single and Double Sided), analysis, relation between Laplace Transform and Z-Transform.
8. Fourier series representation, properties, problems on Fourier series and Fourier Transform.
10. Relation between Fourier and Laplace, Solutions to differential equations

**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.

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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 examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

**Term work:**
Term work consists of minimum eight tutorials. The distribution of the term work shall be as follows,

- Laboratory work (Experiments / Assignments) : 10 marks
- Laboratory work (Programs / Journal) : 10 marks
- Attendance (Practical and Theory) : 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>
<thead>
<tr>
<th>Sub code</th>
<th>Subject Name</th>
<th>Theory</th>
<th>Pract.</th>
<th>Tut.</th>
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<th>Pract.</th>
<th>Tut.</th>
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<tbody>
<tr>
<td>ISC502</td>
<td>Applications of Microcontroller - I</td>
<td>4</td>
<td>2</td>
<td>-</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>5</td>
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<thead>
<tr>
<th>Sub code</th>
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<th>Examination Scheme</th>
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<tr>
<td>ISC502</td>
<td>Applications of Microcontroller - I</td>
<td>Internal Assessment (out of 20)</td>
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<td>Test 1</td>
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<tr>
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<th>Subject Name</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>ISC502</td>
<td>Applications of Microcontroller - I</td>
<td>5</td>
</tr>
</tbody>
</table>

Course Objectives
- To make the students understand the fundamentals of 8051 Microcontroller. Students should understand the working of these systems and should be able to determine hardware and software interfacing with real time systems. They should further understand how to design any application based on these systems.

Course Outcomes
- The students will be able to
  - Define Microprocessor and Microcontroller family with comparison.
  - Understand working of 8051/8052 and MCS251 Microcontroller Architecture and Programming model.
  - Understand the concept of Timer, Interrupt, I/O Port interfacing with 8051 Microcontroller.
  - Understand the concept of Interfacing with Real time System.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction</strong></td>
<td>05</td>
</tr>
<tr>
<td></td>
<td>Microprocessor Definition, Microcontroller Definition, Operation of ALU, Evolution of Microprocessors, Block Diagram of microprocessor based system and development cycle, RISC and CISC processors</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>MCS-51 microcontroller</strong></td>
<td>09</td>
</tr>
<tr>
<td>3</td>
<td><strong>Advanced MCS-51 architecture</strong></td>
<td>06</td>
</tr>
</tbody>
</table>

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8052 enhancements
Indirect Memory access, Timer2, PCA
Architecture of MCS151
Architecture of MCS251

4 **Programming & Tools**
Simulator, in-circuit debugger, in-circuit emulator, programmers, integrated development environment (IDE), cross compilers. Merits & demerits of above tools.

5 **Serial communication protocols**
Operation of serial port. Programming for implementation of asynchronous serial communication.
Buses like
I2C
RTC – DS1307
EEPROM Memory – 24C256
SPI – MCP3201

6 **Interfacing & Case Studies**
Interfacing to LCD, 7 segment display, ADC, DAC, relay, opt isolator.
Data acquisition systems, Digital weighing machine, Washing machines, PID temperature controller, Speed Control of DC motors and similar system design

**List of Experiments:**

1. 16 bit Arithmetic operations (addition, subtraction, multiplication)
2. Logical operation
3. Code conversion
4. Generating square wave on port pins.
5. Generation of square wave using timer
6. Interfacing keyboard, 7 segments displays.
7. Interfacing LCD display
8. Serial Communication with PC.
9. Interfacing RTC
10. Interfacing DAC and its application
11. Temperature Controller
12. Speed control of DC Motor
13. Frequency measurement
14. Implementing PID controller
15. Stepper motor control.

**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.

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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:**
3. Manoharan et.al , Microcontroller based system design, Scitech Publications (India) Pvt. Ltd.
4. 8051 / MC151 / MCS251 Datasheets

**Websites:**
1. www.atmel.com
2. www.microchip.com
3. www.nXp.com
### Course Objectives

- To make students understand the concept of state–space analysis, to design the compensator in time and frequency domain, to design the PID compensator.

### Course Outcomes

The students will be able to

- Represent any system in any canonical form.
- Determine response of system
- Design Lead, Lag and Lead–lag compensator using frequency domain method or time domain method.
- Design PID compensator.

### Module

**Topics**

1. **Review:** Time and Frequency domain specifications, error constants, effect of addition of poles and zeros on the system response, stability analysis using bode plot and root-locus techniques.

2. **State-Space Analysis of Control system:**
   - Concept of state-space and state model for Linear systems-SISO and MIMO systems, Linearization, State model for Linear continuous time system, State-space representation using phase variables, phase variable formulation for transfer function with poles and zeros, State-space representation using Canonical variables, derivation of transfer function from state model, Diagonalization, eigenvalues and eigenvectors, Solution of State equations - properties of state transition matrix, computation of state transition matrix using Laplace Transformation, Cayley – Hamilton theorem.
### 3. Controller Design using State-Space:
- Concept of controllability and observability, definitions, phase variable form, properties, effect of pole-zero cancellation in transfer function, **State Feedback and Pole placement** – Stabilizability, choosing pole locations, limitations of state feedback
- **Tracking Problems:** Integral control
- **Controller design** - for phase variable form, by matching coefficients, by transformation.

### 4. Introduction to Compensator:
- Analysis of the basic approaches to compensation, cascade compensation, feedback compensation, Derivative and integral error compensation, Limitations of actuator saturation on controller design.
- **Compensator Design using Root-locus:**

### 5. Compensator Design using Frequency response:
- Steady-state error characteristics of Type 0,1, and 2 systems, Time delay, transient response through gain adjustment, Lag, Lead, Lag-Lead compensation.

### 6. PID Compensator Design:

### List of Laboratory Experiments (Using MATLAB/Scilab or any equivalent software):
1. Design of Lead Compensator in Time domain.
2. Design of Lag Compensator in Time domain.
4. Design of Lead Compensator in Frequency domain.
5. Design of Lag Compensator in Frequency domain.
6. Design of Lag-Lead Compensator in Frequency domain.
7. Design of PID in Time domain.
8. Design of PID in Frequency domain.
10. Verification of controllability and observability.

### 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 examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

**Term work:**
Term work consists of minimum eight experiments two case studies. The distribution of the term work shall be as follows,

| Laboratory work (Experiments / Assignment) | 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.

**Case Study:**
1. Design a controller using time-domain/frequency domain/pole placement approach for an inverted pendulum on a cart and simulate the same using MATLAB/Scilab.
2. Design a controller using time-domain/frequency domain/pole placement approach for speed control of DC motor and simulate the same using MATLAB/Scilab.
3. Design a controller using time-domain/frequency domain/pole placement approach for Magnetic levitation system and simulate the same using MATLAB/Scilab.
4. Design a controller using time-domain/frequency domain/pole placement approach for any other physical system available in laboratory (Flow loop, pressure loop, level loop etc.) and simulate the same using MATLAB/Scilab.

**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>ISC504</td>
<td>Signal Conditioning Circuit Design</td>
<td>5*</td>
<td>2</td>
</tr>
</tbody>
</table>

* Out of 5 Theory lecture hours – 4 hours would be Lectures and 1 hour would be for Miniproject (for entire class)

<table>
<thead>
<tr>
<th>Sub code</th>
<th>Subject Name</th>
<th>Examination Scheme</th>
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<tr>
<td></td>
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<tr>
<td>ISC504</td>
<td>Signal Conditioning Circuit Design</td>
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<table>
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<tr>
<th>Subject Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISC504</td>
<td>Signal Conditioning Circuit Design</td>
<td>5</td>
</tr>
</tbody>
</table>

Course Objectives
- To make students understand the working principle and design of various analog and digital signal conditioning circuits used in industrial applications.

Course Outcomes
- The students will be able to
  - Understand principle of working of various signal conditioners used with Temperature, Displacement, Optical and various miscellaneous other sensors.
  - Design signal conditioning circuits for various transducers.
  - Understand applications of various signal conditioners used in industry.
  - Capable of selecting best suited signal conditioners for any given application.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Components of Analog Signal Conditioning:</strong> Standard analog signals,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signal Level and bias changes, Linearization, conversion, filtering and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>impedance matching, concept of loading.</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Passive signal conditioners</strong> – Voltage divider, Wheatstone bridge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>circuits (Current, Voltage, Balanced and Unbalanced), RC filters.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Analog signal conditioners and their design:</strong> Practical applications of Op-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>amp based circuits with design - Differentiators and Integrator, 3 op-amp</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Instrumentation amplifier with applications, Precision rectifiers – Half wave,</td>
<td></td>
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<tr>
<td></td>
<td>full wave, absolute value circuit, Log and anti-log amplifier with</td>
<td></td>
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<tr>
<td></td>
<td>temperature compensation and applications, Active filters, sample</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and hold circuit , peak</td>
<td></td>
</tr>
</tbody>
</table>

University of Mumbai, Instrumentation Engineering, Rev 2012-13  14
<table>
<thead>
<tr>
<th>3</th>
<th><strong>Components of Digital Signal Conditioning</strong>: Converters – ADCs and their different types, DACs and their different types, V to F and F to V converters. 555 Timer – modes of operation with applications. Characteristics of digital data – digitized value, sampled data system and linearization. Data acquisition system design, Encoders and Data logger circuit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td><strong>Thermal and Pressure Transducer Signal conditioning Design</strong>: Thermal sensor signal conditioning – design considerations and applications for RTD, Thermistor, thermocouple and solid state temperature sensors. Pressure sensor signal conditioning - design considerations and applications for various pressure sensors.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Optical and Other Transducer Signal Conditioning Design</strong>: Optical sensor signal conditioning – photo-diode with photo-conducting and photovoltaic modes, photo-transistor and photomultiplier tube. Optical encoder signal conditioning for linear displacement, velocity and angular displacement applications. Other sensor signal conditioning – Potentiometer, LVDT, strain gauges, piezoelectric transducer and capacitive transducers.</td>
</tr>
<tr>
<td>6</td>
<td><strong>Power Supply Design</strong>: Power supply design using 78xx series, 79xx series and adjustable voltage IC regulators like 723 and 317. Switched Mode Power Supply (SMPS) – Block diagram with advantages and disadvantages over conventional power supply.</td>
</tr>
</tbody>
</table>

**List of Experiments:**

1. To design general signal conditioning circuit to convert sensor output to 0-5 V
2. To design general signal conditioning circuit to convert sensor output to 4-20 mA
3. To design signal conditioning circuit for low level signals in micro-volts region
4. To design absolute value circuit for an application
5. To design signal conditioning circuit for weight measuring system using strain gauge

*University of Mumbai, Instrumentation Engineering, Rev 2012-13*
6. To design signal conditioning circuit for capacitive transducer  
7. To design a second order LPF and HPF for any application  
8. To design signal conditioning circuit for RTD  
9. To design signal conditioning circuit for LDR  
10. To design an analog-to-digital convertor circuit for an application  
11. To design and implement Astable and Monostable Multivibrator using 555 timer  
12. To design adjustable voltage regulators using IC723/ LM317

**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 examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

**Miniproject/ Orals:**

Students in group of 2-3 would perform a Mini-project on any one application of signal conditioning circuit design and appear for Oral examination of the same.

**Term Work:**

Term work shall consist of minimum eight experiments (04 experiments from experiment list of 1 to 6 and 04 experiments from experiment list of 7 to 12)

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

<table>
<thead>
<tr>
<th>Component</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>Laboratory work (Experiments)</td>
<td>10</td>
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<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:

Reference Books:
3. C. D. Johnson, “Microprocessor Based Process Control”, PHI
<table>
<thead>
<tr>
<th>Sub code</th>
<th>Subject Name</th>
<th>Teaching Scheme (Hrs)</th>
<th>Credit Assigned</th>
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</thead>
<tbody>
<tr>
<td>ISC505</td>
<td>Control System Components</td>
<td></td>
<td>5</td>
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</table>

<table>
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<tr>
<th>Sub code</th>
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<th>Pract.</th>
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<tr>
<td>ISC505</td>
<td>Control System Components</td>
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<td>2</td>
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<td>4</td>
<td>1</td>
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<tr>
<th></th>
<th>Examination Scheme</th>
<th></th>
<th>Internal Assessment (out of 20)</th>
<th>Term Work</th>
<th>Pract. and oral</th>
<th>Oral</th>
<th>Total</th>
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<td>ISC505</td>
<td>Control System Components</td>
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<td>Test 1</td>
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<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ISC505</td>
<td>Control System Components</td>
<td>5</td>
</tr>
</tbody>
</table>

**Course Objectives**
- This course develops the students approach to identify different Control system components like Hydraulic, Pneumatic, Electrical and Electronic.
- Students are expected to learn different types of Transmitters.
- Students are expected to understand concept of Control Valve, different types of Control valve, their schematic, operation, etc.
- They should able to understand different auxiliary process components like feeders, dampers etc.

**Course Outcomes**
- The students will demonstrate different control system components like pumps, compressors, flapper nozzle.
- The students will demonstrate working of different pneumatic circuits like Single acting cylinder, Double acting cylinder, hydraulic braking systems by using directional control valves.
- The students will demonstrate the knowledge of different transmitters, how to use SMART transmitter.
- The students will demonstrate the knowledge of control valves, installation, different valve accessories.
- The students will learn importance of Alarm annunciators system, square root extractor, pressure and level switches.
<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Pneumatics</strong>&lt;br&gt;Pneumatic System Components: ISO symbols&lt;br&gt;Instrument Air and Plant Air ,Air supply system and its components, Air compressors, Pressure regulation devices, air dryers , Directional control valves and special types of pneumatic valve such as Pilot-operated valves, Non-return valves, Flow control valves, Sequence valves, and Time delay valve, Linear actuators- Single-acting, Double-acting, and special type of double-acting cylinder, Rotary actuators- Air motors, Process Control Pneumatics: Flapper Nozzle system, Volume boosters, Air relays, Pneumatic transmitters and controllers, Pneumatic logic gates , Pneumatic Circuits- Standard Symbols used for developing pneumatic circuits.</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td><strong>Hydraulics</strong>&lt;br&gt;Hydraulic System Components:&lt;br&gt;Hydraulic pumps, Pressure regulation method, Loading valves, Hydraulic valves, Hydraulic actuators (cylinder and motor) , Speed control circuits for hydraulic actuators , Selection and comparison of pneumatic, hydraulic and electric systems.</td>
<td>03</td>
</tr>
<tr>
<td>3</td>
<td><strong>Transmitters</strong>&lt;br&gt;Need of transmitter, Need for Standardization of signals, concept of live zero and dead zero, 2-wire; 3-wire and 4-wire current transmitters, Electronic versus pneumatic transmitters, Electronic type transmitters -temperature; pressure; differential pressure; level; flow transmitter, SMART (Intelligent) Block schematic and Comparison with conventional transmitter, Buoyancy transmitter and their applications, Converters- Pneumatic to Electrical and Electrical to Pneumatic converters.</td>
<td>06</td>
</tr>
<tr>
<td>4</td>
<td><strong>Process Control Valves</strong>&lt;br&gt;Control valve terminology: Rangeability, Turndown; Valve size; control valve capacity and valve gain, Air to Open(AO), Air to Close (AC) ,selection criterion etc. MOC (Material of construction), type of actuation, applications, advantages, disadvantage of - Globe, Ball, Needle, Butterfly, Diaphragm, Pinch, Gate, Solenoid, Smart control valves, and special designs of Globe valves. Flow characteristics (Inherent and Installed), Valve positioners: necessity, types-motion balance and force-balance, effect on performance of control valve.Control Valve Actuators- Electrical, Pneumatic, Hydraulic, Electro-mechanical, and Digital actuators. Selection criteria of valve actuators.</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td><strong>Auxiliary Process Control Components</strong>&lt;br&gt;Construction, working &amp; application area of-Synchros (Transmitter and Receiver), error detector, Alarm annunciators Fire and gas detectors (types –flame, gas, fire and gas siren), Square root extractor, Feeders, Dampers, Temperature regulator, Flow regulator, Temperature , Flow, Level and, Pressure Switch, Relief valves, safety valves and rupture disk, Thermostats and Humidistat, Steeper motor</td>
<td>4</td>
</tr>
</tbody>
</table>
Industrial Control Components

Switches: Construction, symbolic representation, working, application of Toggle switches, Push buttons, Selector switches, DIP switches, Rotary switches, Thumbwheel switches, Drum switch, Limit switches- contact, non contact- type, Switch specifications.

Control Relays: Construction, working, specifications, selection criteria and applications of Electro-mechanical relay, Reed relay, hermetically sealed relay, Solid state relays. Interposing relays and Overload relays.

Contactors/starters: Construction, working, specifications and applications of starters and contactors. Comparison between relays and starters/contactors.

RFID - basic principles, frequencies, Active and passive RFID systems, mode of communication, various technologies for In house and outdoor RFID systems, Basic theory and devices for vision components, sensors and systems, Image processing and multi camera systems.

List of Experiments:

1. Study of various pneumatic and hydraulic system components.
2. Development, implementation and testing of pneumatic circuits.
3. Development, implementation and testing of hydraulic circuits.
4. Study of operation and calibration of 2-wire DP transmitter for flow and level control.
5. Design of a two-wire temperature transmitter.
7. Calibration of I to P and P to I converters.
8. Study of control valve Flow characteristics.
10. Study of different types of control valve actuator.
11. Study of pressure/temperature/level/flow switches.
12. Study of square root extractor.
13. Study of different types of control relay.

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 examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.
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
- 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:

1. Pneumatics, Festo Didactic.
2. Hydraulics, Festo Didactic
5. Less Driskell, *Control Valve Selection and 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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<tbody>
<tr>
<td>ISC601</td>
<td>Process Instrumentation Systems</td>
<td>4</td>
<td>2</td>
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<tr>
<th>Sub code</th>
<th>Subject Name</th>
<th>Examination Scheme</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Theory (out of 100)</td>
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<tr>
<td></td>
<td></td>
<td>Internal Assessment (out of 20)</td>
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<tr>
<td></td>
<td></td>
<td>Test 1</td>
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<tr>
<td>ISC601</td>
<td>Process Instrumentation Systems</td>
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<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISC601</td>
<td>Process Instrumentation Systems</td>
<td>5</td>
</tr>
</tbody>
</table>

**Course Objectives**
- The objective of the course is to make the students familiar with different process dynamics in Process industries and different control schemes generally used to get best output. It also makes students aware of various analysis and design methods for multivariable systems. In addition, the subject also introduces about discrete state process control and Batch process.

**Course Outcomes**
- The students will be able to handle any kind of process by framing it in block diagram, mathematical model and different process variables.
- The students will be able to handle different types of controller like electronic, pneumatic and hydraulic.
- The students will be able to implement different control schemes to various processes.
- The students will be able to design relay logic for various processes.
- The students will be able to understand batch process with an example.

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Process dynamics</strong>&lt;br&gt;Dynamic elements in a control loop, Dead time processes and Smith predictor compensator. Inverse response behavior of processes and compensator. Dynamic behavior of first and second order systems. Interacting and non-interacting systems.</td>
<td>04</td>
</tr>
</tbody>
</table>

|          | **Process Control Action**<br>Elements of process control, Controller Principle, Process Characteristics, Control system parameters, discontinuous, continuous and composite | 10   |
controller modes/actions (P,I,D,PI,PD and PID).

3 **Process Controllers and Tuning**
   General features, construction and working of Pneumatic, Hydraulic and Electronic controller.

4 **Control Schemes**
   Feedback, feedforward, cascade, ratio, split range, selective control, adaptive control, and model based control.

5 **Multivariable Control**
   Block diagram analysis of multivariable systems, Interaction, Tuning of Multivariable controllers, relative gain analysis, Decoupler design

6 **Discrete-State process control**
   Discrete state process control characteristics of the system, variables, process specification and event sequence description, Physical ladder diagram elements and examples.
   Introduction to Batch Process with example.

**List of Experiments:**
1. Study of ON-OFF Controller.
2. Study of controller modes (pure and composite) on a PID controller with a recorder.
4. Tuning of a PID controller.
5. Study of feedback feed forward controller.
7. Study of split range control.
8. Study of Ratio control.
9. Interaction analysis using RGA for a MIMO process.

**Note:** All above experiments should be performed on a pilot plant for real time I/Os

**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 examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

University of Mumbai, Instrumentation Engineering, Rev 2012-13  23
Term Work:
Term work shall consist of minimum eight experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments / 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 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. F.G. Shinsky, Process Control System, TMH.
B. Taraporewala Sons and co. pvt ltd. – 1996

University of Mumbai, Instrumentation Engineering, Rev 2012-13  24
### Course Objectives
- To equip the students with the basic knowledge of Power semiconductor Devices
- To study the controlled Rectifiers, Inverters and DC to DC converters.
- To Understand the working AC and DC Drives.
- To Study the application of Power Electronics.

### Course Outcomes
Students will be able to
- Understand the working of Power Electronics Devices.
- Understand working of Controlled Rectifiers, Inverters and DC to DC converters.
- Understand the Working of AC/DC Drives.

### Chapter 1: Power Semiconductor Devices

#### Contents
- Introduction to construction, characteristics, ratings & applications of power diodes, power BJT, power MOSFET & IGBT.
- Study of Thyristors: construction, characteristics, ratings of SCR, TRIAC, GTO.
- Switching/triggering methods: switching methods/types of triggering devices like DIAC, UJT & PUT
- Thyristor commutation Tech. (basic concepts), protection scheme against over-current, over voltage, dv/dt cooling technique

#### Hours
12

### Chapter 2: Thyristor Application

#### Contents
- Controlled rectifiers: Principles of operations of phase controlled converters, single phase half bridge, semi converter & bridge converters, effect of source inductance on fully controlled bridge converter, performance parameters Design of SCR based DC power circuits including UJT as triggering device

#### Hours
10
<table>
<thead>
<tr>
<th></th>
<th>AC power control using SCR-UJT &amp; TRIAC-DIAC like universal speed controller fan regulator Design of SCR/TRIAC based AC power control circuits including UJT/DIAC as a triggering device</th>
</tr>
</thead>
</table>
| 3 | **INVERTER**  
|   | Principles of operation of inverters, PWM inverter, bridge inverter, basic circuit scheme of IGBT/ power MOSFET based inverter circuits harmonic reduction in inverter output. Inverter circuits using H bridge for 3-phase output. |
|   | **DC to DC Converters**  
|   | Basic operation of choppers, study of diff. types of chopper circuits like step up, step down chopper, four quadrant operation of chopper, Basic concept of SMPS and Analysis of various conduction modes of Buck, Boost, Buck-Boost, Cuk converter; design and selection of inductor and capacitor for converters. |
| 5 | **Drives**  
|   | AC Motor Drives: Concept & requirement of drives, Current fed & Voltage fed drives, rotor resistance control & v/f control of AC motors  
|   | DC Motor Drives : DC Drives for brushed/brushless motors |
| 6 | **INDUSTRIAL APPLICATIONS**  
|   | Induction & dielectric heating process, block diagram, merits/demerits  
|   | Applications of power electronics in traction |

**List of Laboratory Experiments:**

1. SCR Characteristics.
2. TRIAC & DIAC characteristics.
3. Study of various triggering circuits
4. Half wave & full wave controlled rectifier
5. IGBT based inverter
6. SCR/TRIAC based AC power control circuit
7. DC motor speed control using chopper
8. PWM drive for Induction motor using IGBT

**Theory Examination:**

1. Question paper will consist of total 6 questions carrying 20 marks each.
2. Only 5 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.

**Practical & Oral Examination:**

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.
Term work:
Term work consists of minimum eight experiments from the list, two simulations of Power Electronics Circuits and a written test. The distribution of the term work shall be as follows,

- Laboratory work (Experiments / Assignments) : 10 marks
- Laboratory work (Programs / Journal) : 10 marks
- Attendance (Practical and Theory) : 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:
1. P.S. Bhimbra, Power Electronics, Khanna publishers, 2004

Reference Books:
7. Modern Electric Traction by Pratab ,Dhanpat Rai and sons ,Delhi

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<table>
<thead>
<tr>
<th>Sub Code</th>
<th>Subject Name</th>
<th>Teaching Scheme (Hrs)</th>
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<td></td>
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<td>Theory</td>
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<tr>
<td>ISC603</td>
<td>Digital Signal Processing</td>
<td>4</td>
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<td>Theory(Out of 100)</td>
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<td>Term Work</td>
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<tr>
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<tbody>
<tr>
<td>ISC603</td>
<td>Digital Signal Processing</td>
<td>5</td>
</tr>
</tbody>
</table>

**Course Objectives**

- The principle of the syllabus is to give an introduction to basic concepts of system transforms, fundamental principles and applications of signals and filters.
- This subject provides understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.

**Course Outcomes**

- Upon successful completion of this subject, student will be able to,
  - Determine the frequency response of FIR and IIR filters.
  - Understand the relationship between poles, zeros, and stability.
  - Determine the spectrum of a signal using the DFT, FFT, and spectrogram.
  - Design, analyze, and implement digital filters in Matlab and C,C++.
<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brief review: Discrete time signals and systems, difference equations, Fourier series &amp; Transform, Z-Transform, theorems, properties etc. <strong>Introduction to digital signal processing:</strong> Block diagram of DSP, Advantages, and Sampling Theorem, Classification of Digital Filter (IIR and FIR).</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td><strong>Discrete Fourier Transform:</strong>-Introduction to DTFT, Fourier representation of finite duration sequences, the Discrete Fourier Transform, properties of the DFT, Linear convolution using the DFT and IDFT. <strong>Computation of the Discrete Fourier Transform:</strong> - Decimation in frequency (DIF) algorithms, Decimation in time (DIT) algorithms for Radix 2, 3 composite. Overlap add and save Methods.</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td><strong>Analysis of Digital Filter:</strong> - Classification of filter on their pole zero diagram. Frequency response of IIR filters frequency response analysis of all types of linear phase system. Difference between IIR and FIR Filters. <strong>Realization of systems:</strong> -Realization of IIR systems by Direct form-I, Direct form-II, Cascade and Parallel. Realization of FIR systems by Direct form, cascade and linear phase system.</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td><strong>Digital Filter Design Techniques:</strong>-Properties of IIR filter Discritization Methods like IIT and BLT. Design of Butterworth and Chebyshev-I IIR filter.</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td><strong>FIR filter Design:</strong>-Design of FIR filter by using Different Windowing Technique. By using Frequency Sampling. Realization of system by using Frequency Sampling Technique.</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td><strong>Multi rate Signal Processing:</strong>-Sampling rate reduction: decimation by integer factors, Sampling rate increase: interpolation by integer factors, sampling rate conversion by non integer factors. <strong>Introduction to Digital Hardware and Applications:</strong>-Digital signal processor series Texas 320, Motorola 56000. Applications to speech, Radar, CT scanner and Digital touch tone receiver.</td>
<td>6</td>
</tr>
</tbody>
</table>

**List of experiments:**

(Experiments 1 to 6 Using C or C++ and verifying the results using MATLAB)

1. Program for finding linear convolution.
2. Program for finding circular convolution.
3. Program for finding linear convolution using circular convolution.
4. Program for finding correlation (auto and cross).
5. Program for finding DFT's. & IDFT.
6. Implementation of FFT algorithms (DIT, DIF) etc.
7. Program on filter designing (FIR) (Using MATLAB only).

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8. Program on Filter Designing. (IIR) (Using MATLAB only).
9. Minimum two assignments based on structure realizations (IIR, FIR).
10. Study of any DSP processor series and their differences.

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 examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

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>ISC604</td>
<td>Applications of Microcontroller - II</td>
<td>Theory: 4, Pract.: 2, Tut.: -</td>
<td>Theory: 4, Pract.: 1, Tut.: -</td>
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<tr>
<td>ISC604</td>
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<td>Internal Assessment (out of 20): 20</td>
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<td>Term Work: 80</td>
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<td>Oral: 25*</td>
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Subject Code | Subject Name                        | Credits |
-------------|------------------------------------|---------|
ISC604       | Applications of Microcontroller - II | 5       |

Course Objectives
- To make the students understand the fundamentals of PIC Microcontroller. Students should understand the working of these systems and should be able to determine hardware and software Interfacing with real time systems. They should further understand how to design any application based on these systems.

Course Outcomes
The students will be able to
- Define Embedded system and its Applications in industry.
- Understand working of PIC 18F Microcontroller Architecture and Programming model.
- Understand the concept of Timer, Interrupt, I/O Port interfacing with PIC 18F Microcontroller.
- Understand the concept of Interfacing with Real time System.

Module | Topics                                                                 | Hrs. |
--------|------------------------------------------------------------------------|------|
1       | **Embedded systems:** Definition, embedded system overview, classifications, Design challenges, processor technology, IC technology and Design Technology and tradeoffs. Examples of embedded system. | 04   |
2       | **PIC 18F Microcontroller architecture Hardware**

- PIC 18F Microcontroller family, PIC18F architecture, features
- PIC18F4520, Block diagram, Oscillator configuration, power saving modes

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PIC 18F Software:
PIC 18F Instruction set, Instruction format, Integrated Development Environment (IDE), Assembling, Debugging, and Executing a program Using MPLAB IDE in assembly and embedded C, Data copy operation, Arithmetic operation, Branch and Skip operation, Logic operations, bit Operation, Stack and Subroutine, Code conversion programs and Software Design.

Case Study:
I/O port Interfacing, Interfacing O/P peripherals such as seven segment LED, LCD, Interfacing I/P peripheral such as push button keys, Matrix keyboard, interfacing sensors using Analog to Digital convertor module, D/A convertor module, Interfacing a temperature sensor to the A/D convertor module. PWM generation for different applications.

Serial I/O:
Basic concept in serial communication, EIA-232 and PIC 18 serial communication module, USART, SPI, I²C (Inter-Integrated Ckt) Protocol.

Real Time Operating System (RTOS)
Introduction to RTOS concept, RTOS Scheduling models. Task scheduling examples using different algorithms. Interrupt latency and response times of the tasks as performance metrics. Example of any tiny RTOS.

List of Experiments:
16. 16 bit Arithmetic operations (addition, subtraction, multiplication)
17. Logical operation
18. Code conversion
19. Generating square wave on port pins.
20. Generation of square wave using timer
21. Interfacing keyboard, 7 segments displays.
22. Interfacing LCD display
23. Serial Communication with PC.
24. Interfacing RTC
25. Interfacing DAC and its application
26. Temperature Controller
27. Speed control of DC Motor
28. Frequency measurement
29. Implementing PID controller
30. Stepper motor control.

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 examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

**Term Work:**

Term work consists of minimum eight tutorials. 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.

**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:**

3. Peatman, Design with PIC Microcontroller, Pearson Education.
4. Han-way Huang, PIC Microcontroller, India Edition

**Websites:**

1. www.microchip.com
2. [www.atmel.com](http://www.atmel.com)
3. [www.nxp.com](http://www.nxp.com)
<table>
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<td>ISC605</td>
<td>Industrial data</td>
<td>4</td>
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<td>communication</td>
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<td>communication</td>
<td>Internal Assessment (out of 20)</td>
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<tr>
<td>ISC605</td>
<td>INDUSTRIAL DATA COMMUNICATION</td>
<td>5</td>
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</table>

**Course Objectives**
- To make students understand the OSI reference model, LAN network, different Open control network, Networks at different levels such as sensor level, device network control, HART, Foundation field bus, Wireless technologies

**Course Outcomes**
The students will be able to
- Understand basic reference model, LAN for networking.
- Understand various architecture/working of different protocol.
- Make comparative study of various wireless technology.
- Understand applications of various protocols in industry.

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<tr>
<td>1</td>
<td><strong>Introduction:</strong> OSI reference model, LAN architecture and topology Transmission media: UTP cable, STP cable, co-axial cable, fiber optics, wireless media Data Link Layer, MAC sublayer (media access algorithms), error detection and correction code Network components: repeaters, bridge, hub, switch, router, gateways</td>
<td>09</td>
</tr>
<tr>
<td>2</td>
<td><strong>Open control network:</strong> RS232, RS422, EIA 485, Ethernet- MODBUS – structure, function codes and implementation, General Purpose Instrument Bus, specifications. <strong>Proprietary control network:</strong> MODBUS plus, data highway plus.</td>
<td>07</td>
</tr>
<tr>
<td>3</td>
<td><strong>Networks at different levels:</strong> Sensor level network: AS-i, CAN, Devicenet, Interbus and LON Device network: Foundation Fieldbus –H1, HART, PROFIBUS-PA</td>
<td>08</td>
</tr>
</tbody>
</table>
Control network: BACnet, ControlNet, FF-HSE, PROFIBUS-DP, Ethernet, TCP/IP

4  **HART:**
   Architecture – physical, data link, application layer, communication technique, normal and burst mode of communication, troubleshooting, benefits of HART.  

06  

5  **Foundation fieldbus:**
   Fieldbus requirement, features, advantages, fieldbus components, types, architecture–physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process.
   **OPC Architecture**

12  

6  **Wireless technologies:**
   Satellite systems, Wireless LANs (WLANs), WiFi, VPAN, Zigbee, bluetooth GPRS and – their comparison, limitations and characteristics.

06

**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.

**Practical & Oral Examination:**

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

**Term Work:**

Term work consists of minimum eight experiments based on above syllabus, two assignment. The distribution of the term work shall be as follows,

- Laboratory work (Experiments and Journal) : 10 marks
- Test (at least one) : 10 marks
- Attendance (Practical and Theory) : 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.
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1. Deon Reynders, Steve Mackay, Edwin Wright, *Practical Industrial Data Communications*, 1\textsuperscript{st} edition ELSEVIER, 2005.

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<td>Pract</td>
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<td>Analytical Instrumentation</td>
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<td>Analytical Instrumentatio n</td>
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<tbody>
<tr>
<td>ISC606</td>
<td>Analytical Instrumentatio n</td>
<td>4</td>
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</table>

**Course Objectives**
- To introduce the basic concept of qualitative and quantitative analysis of a given sample.
- To study various spectroscopic techniques and its instrumentation.
- To study the concept of separation science and its applications.
- To study the concept of industrial analyzers and its applications.

**Course Outcomes**
- The students get well versed with the principle, construction and working of various analytical instruments.
- Students get detailed information about the applications of analytical techniques in medicine, industry etc.

<table>
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<tr>
<th>Module</th>
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</thead>
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<tr>
<td>1</td>
<td><strong>Introduction</strong>: Introduction to analytical process, selection of instruments for application in industries. Compare classical analytical techniques with instrumental techniques. <strong>Fundamentals of Spectroscopy</strong>: Nature of Electromagnetic Radiation, Electromagnetic spectrum, Numerical on EMR and laws of photometry. Introduction to spectroscopic methods, Instrumentation of spectroscopic analytical system – Radiation sources, filters and monochromators, diffraction grating, detectors, signal processors and readout modules.</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td><strong>Molecular Spectroscopy</strong>: Molecular Energy levels, correlation of energy levels with transitions. <strong>a) Electronic transitions and Vibrational transitions</strong> – Introduction to UV-VIS molecular spectroscopy – basics of single beam, double beam spectrophotometer and filter photometer, its instrumentation and applications. Fluoroscopy, Phosphoroscopy and Raman Spectroscopy – basic principle, components and its instrumentation. Basic principle</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td><strong>Atomic Spectroscopy:</strong> Atomic Energy levels, Atomic absorption spectroscopy – components, working and absorption spectra. Atomic Emission spectroscopy – components, working and emission spectra, comparison between AAS and AES.</td>
<td></td>
</tr>
</tbody>
</table>
| 4 | **Separation Science:**
| a) **Chromatography:** Fundamentals of chromatographic separations, classification. Solid, liquid, gas chromatographic system with components, factors affecting separation, applications. Analysis of Gas Chromatogram.
| b) **Mass Spectrophotometers:** Components of Mass Spectrometer, Types of mass spectrometers, sample handling techniques for liquids and solids, resolution, numericals on resolution. Interfacing Chromatography and Mass spectrometry. |
| 5 | **Radio Chemical Instrumentation:**
| Radio chemical methods, radiation detectors – Ionization chamber, Geiger Muller counter, proportional counter, scintillation counter, semiconductor detectors, pulse height analyzer.
| X-ray spectroscopy and Gas analyzers:
| Production of X-ray spectra, Instrumental methods, detectors, X-ray absorption meters. |
| 6 | **Industrial Gas Analyzers:**
| Oxygen, carbon dioxide (CO2), carbon monoxide (CO), NOx analyzers, Gas density analyzer, online gas analyzers. |

**List of Laboratory Experiments:**
1. Photoelectric Colorimeter
2. Nephalo-turbidity meter
3. Densitometer
4. Refractometer
5. Single beam Spectrometer for UV/VIS range.
6. Double beam Spectrometer for UV/VIS range.
7. Gas Chromatograph
8. Atomic absorption spectrometer
9. Balance Cell Calorimeter
10. Spectroflourimeter
11. Geiger Muller Counter.
12. Scintillation Counter.

**Theory Examination:**
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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 and weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

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