Bansilal Ramnath Agarwal Charitable Trust’s
Vishwakarma Institute of Technology, Pune – 411 037
Department of Instrumentation and Control Engineering

Bansilal Ramnath Agarwal Charitable Trust’s

Vishwakarma Institute of Technology
(An Autonomous Institute affiliated to University of Pune)

Structure & Syllabus of

B.E. (Instrumentation and Control)
Effective from Academic Year 2011-12

Prepared by: - Board of Studies in Instrumentation Engineering
Approved by:- Academic Board, Vishwakarma Institute of Technology,
Pune.

Signed by,

Chairman – BOS

Chairman – Academic Board

Structure & Syllabus of B.E. (Instrumentation & Control) Program – Pattern ‘A11’, Issue No. 3,
Rev 01, dated 02-04-2011
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6.11 IC24304 Photo-voltaic Applications (Skills Development Course)
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6.13 IC24308 Analytical Instrumentation (Skills Development Course)
6.14 @ Elective – Health & Hobby
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<td>IC31101</td>
<td>Electronic Instrument and System Design (EISD) (Theory Course)</td>
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<td>IC30103</td>
<td>Microcontroller Based Systems (MBS) (Theory Course)</td>
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<td>IC31105</td>
<td>Digital Signal Processing (DSP &amp; SS) (Theory Course)</td>
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<td>IC30205</td>
<td>Control System Components (Tutorial)</td>
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<td>IC31201</td>
<td>Electronic Instrument and System Design (Tutorial)</td>
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<td>IC30305</td>
<td>CSC &amp; EISD (Laboratory Course)</td>
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<td>MBS &amp; DSP (Laboratory Course)</td>
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8.9 @ Professional Development Course (Institute Level)

8.10 IC30401 Comprehensive Viva Voce - III

9 Course Structure - Module VI

10 Course Syllabi for courses - Module VI

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<th>Course Code</th>
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<td>IC30104</td>
<td>PLC, DCS and SCADA (PDS) (Theory Course)</td>
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<tr>
<td>IC30106</td>
<td>Biomedical Instrumentation (BMI) (Theory Course)</td>
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<tr>
<td>IC31102</td>
<td>Operating Systems (OS) (Theory Course)</td>
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<tr>
<td>IC30202</td>
<td>Process Loop Components (Tutorial)</td>
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<tr>
<td>IC30204</td>
<td>PLC, DCS and SCADA (Tutorial)</td>
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<td>IC30302</td>
<td>PLC &amp; BMI (Laboratory Course)</td>
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<td>IC30304</td>
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10.10 @ Professional Development Course (Institute Level)

10.11 IC30402 Comprehensive Viva Voce - IV

10.12 IC37302 Project Stage I

11 Course Structure - Module VII

12 Course Syllabi for courses - Module VII

<table>
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<td>IC40101</td>
<td>Project Engineering &amp; Management (PEM) (Theory Course)</td>
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#### 12.2 IC40103  Process Control (PC) (Theory Course)  

#### 12.3 Elective -1 Courses: (Theory Course)  
- IC42101  Power Electronics (PE)  
- IC42103  Embedded Systems (ES)  
- IC42105  Biomedical Image Modality (BIM)  

#### 12.4 Elective -2 Courses: (Theory Course)  
- IC42107  Control System Design (CSD)  
- IC42109  Power Plant Instrumentation (PPI)  
- IC42111  VLSI Systems (VLSI)  

#### 12.5 Elective -1 Courses: (Tutorial)  
- IC42201  Power Electronics (PE)  
- IC42203  Embedded Systems (ES)  
- IC42205  Biomedical Image Modality (BIM)  

#### 12.6 Elective -2 Courses: (Tutorial)  
- IC42207  Control System Design (CSD)  
- IC42209  Power Plant Instrumentation (PPI)  
- IC42211  VLSI Systems (VLSI)  

#### 12.7 IC40301  Project Engineering & Management (Laboratory Course)  

#### 12.8 IC40303  Process Control (Laboratory Course)  

#### 12.9 IC47303  Project Stage – II  

#### 13 Course Structure - Module VIII

#### 14 Course Syllabi for courses - Module VIII

#### 14.1 IC40102  Process Instrumentation (PI) (Theory Course)  

#### 14.2 IC40104  Modern Control Theory (MCT) (Theory Course)  

#### 14.3 Elective -3 Courses: (Theory Course)  
- IC42102  Robotics (ROBO)  
- IC42104  Communication Protocols (CP)  
- IC42106  Bio-Image Processing (BIP)  

#### 14.4 Elective -4 Courses: (Theory Course)  
- IC42108  Process Modeling & Optimization (PMO)  
- IC42110  Building Automation & Security Systems (BASS)  
- IC42112  Digital Signal Processors (DSPR)  

#### 14.5 Elective -3 Courses: (Tutorial)  
- IC42202  Robotics (ROBO)  
- IC42204  Communication Protocols (CP)  
- IC42206  Bio-Image Processing (BIP)  

#### 14.6 Elective -4 Courses: (Tutorial)  
- IC42208  Process Modeling & Optimization (PMO)  
- IC42210  Building Automation & Security Systems (BASS)  
- IC42212  Digital Signal Processors (DSPR)  

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<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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<td>IC40302</td>
<td>Process Instrumentation (Laboratory Course)</td>
<td>158</td>
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<td>IC40304</td>
<td>Modern Control Theory (Laboratory Course)</td>
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<tr>
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### 15 Courses Structure for Honors in B.E. (Instrumentation and Control)

#### 16 Course Syllabi for courses offered as Honors

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<th>Course Title</th>
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<td>IC28101</td>
<td>Chemical and Environmental Measurements (Theory Course)</td>
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<td>IC38101</td>
<td>Error Analysis with applications in Engineering (Theory Course)</td>
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<td>IC38102</td>
<td>Bio-Signal Processing (Theory Course)</td>
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<td>IC48102</td>
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<td>IC48301</td>
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### 17 Course Structure for Minor in Instrumentation and Control

#### 18 Course Syllabi for courses offered as Minor in Instrumentation and Control

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<td>IC29101</td>
<td>Fundamentals of Instrumentation (Theory Course)</td>
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<td>IC39101</td>
<td>Sensors and Measurements (Theory Course)</td>
<td>180</td>
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<td>IC39102</td>
<td>Process Loop Components (Theory Course)</td>
<td>183</td>
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<td>IC49101</td>
<td>Microcontroller for Mechanical Systems (Theory Course)</td>
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<td>IC49102</td>
<td>Mechatronics (Theory Course)</td>
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<td>IC39301</td>
<td>Credits for Lab Courses (Group Selection)</td>
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### 19 Course Structure for Minor in Automation

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<td>IC29103</td>
<td>Programmable Logic Controller and HMIs (Theory Course)</td>
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<td>IC39103</td>
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<td>IC39104</td>
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<td>Credits for Lab Courses (Group Selection)</td>
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### 21 ACADEMIC INFORMATION

$ Please Refer Academic Information Section
!

Please Refer F.E.B.E. Structure and Syllabi Booklet

@ Please Refer GP-PD-OE Structure & Syllabi Booklet

Program Educational Objectives (PEO) for
B.E. (Instrumentation and Control Engineering) Program

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<th>PEO No.</th>
<th>Description of the Objective</th>
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<tr>
<td>I</td>
<td>Prepare students with multi disciplinary competency</td>
</tr>
<tr>
<td>II</td>
<td>Prepare students having good balance between analytical skills and hands-on skills</td>
</tr>
<tr>
<td>III</td>
<td>The program cater the needs of industry and research</td>
</tr>
<tr>
<td>IV</td>
<td>Prepare students competency in the area of Automation</td>
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</table>

Course Objectives: Course objectives are specified in the course syllabus

2. Program and Course Outcomes,

Programme Outcomes:
- a. Graduates will demonstrate basic knowledge in mathematics, science and engineering.
- b. Graduate will be familiar with different sensors and transducers.
- c. Graduate will be able to build suitable measurement technique.
- d. Graduates will able to understand electrical circuits and its analysis.
- e. Graduates will be familiar with fundamentals of control system design.
- f. Graduates will have the confidence to apply automation solutions for given industrial applications.
- g. Graduates will demonstrate the ability to design and conduct experiments, interpret and analyze data, and report results.
- h. Graduates will demonstrate the ability to design an instrument and system that meets desired specifications and requirements.
- i. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
- j. Graduates will demonstrate an ability to visualize and work on laboratory and multi-disciplinary tasks.
- k. Graduates will be familiar with various standards and calibration methods used in industry.
- l. Graduates will be able to communicate effectively in both verbal and writtenforms.
- m. Graduate who can participate and succeed in competitive examinations like GATE, GRE.
- n. Graduates will demonstrate an ability to identify, formulate and solve the problems in methods improvement.
- o. Graduate will be familiar with latest technical documentation softwares.
- p. Graduate will be familiar with different industrial project engineering and management documents and softwares.

Course Outcomes: Course outcomes are specified in the course syllabus
MODULE VI
### T. E. Structure (Module VI): FF 653, Issue No. 3, Rev 01 Dated 02/04/2011

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<th>Sub. No.</th>
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<th>Subject Name</th>
<th>Teaching Scheme (Hrs/wk)</th>
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<td>Process Loop Components (PLC)</td>
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</tbody>
</table>

* Multi-disciplinary subject
$ Please Refer Academic Information Section.
@ Please Refer GP-PD-OE Structure & Syllabi Booklet.
IC30102 :: PROCESS LOOP COMPONENTS

Credits: 03  
Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:

- Know the fundamentals of process loop components.
- Select suitable component for given applications.
- Can build suitable control strategy for application.
- Mapping with PEOs: IV (f)

Unit I  (7+1 Hrs)
Fundamentals of process control

A. Elements of process control loop: Concept of process variables, set point, controlled variable, manipulated variable, load variable. Representation of process loop components using standard symbols (basics with reference to control loop).
Process Characteristics: Process equation, capacity, self – regulation, interacting types of disturbances, plant lags like measurement lag, control lag, process lag, distance/velocity lag (dead time) and transfer lag.
B. P & ID for process loops like temperature, flow, level, pressure, etc.

Unit II  (8+2 Hrs)
Transmitters and convertors

A. Introduction: Need of transmitter (concept of field area and control room area), need for standardization of signals, current, voltage, and pressure signal standards, concept of live and dead zero.
Types of transmitters: Two and four wire transmitters, electronic and pneumatic transmitters.
Electronic Differential Pressure Transmitter: Types, installation, calibration setup, application of DPT for level and flow measurement, zero elevation and suppression.
SMART: Comparison with conventional transmitter, block schematic.
Converters: Difference between converter and transmitter, current to pressure converter.
Auxiliary process components: Square root extractor, seals and snubbers.
B. Transmitter circuits, specifications of DPT and SMART transmitter, pressure to current converter, flow totalizer.
Unit III  (8+1 Hrs)
Controllers

A. Discontinuous: Two position, time-proportional control modes
Continuous: Proportional, integral, derivative, proportional-integral, proportional-derivative, proportional-integral-derivative (PID) control modes.
Reset windup, rate before reset, bumpless transfer, effect of process characteristics on PID combination, tuning of controller.
Digital PID controllers: Block schematic, faceplate of Digital controller.
Auxiliary process components: High/low selectors, Alarm annunciator.

B. Multi-position control mode, types of processes versus control action, open loop process reaction method for tuning of controller and computing relay.

Unit IV  (8+1 Hrs)
Control Valve

A. Necessity and comparison with other final control elements.
Control valve terminology: rangeability, turndown, valve capacity, distortion coeff., AO, AC, fail-safe conditions, cavitation, flashing and noise, their effects and remedies.
Control valve characteristics: inherent and installed.
Control valve classification, their construction, advantages, disadvantages and applications of globe, 3-way, diaphragm, rotary, ball, butterfly.
Designing control valve for gas, vapor and liquid services: valve sizing by ANSI/ISA 75.01 std., valve capacity testing by 75.02, high temperature-pressure service valves.

B. Control valve construction: angle, needle and gate, control valve installation, selection and specifications.

Unit V  (8+1 Hrs)
Control valve accessories and actuators

A. Control valve accessories: Need of accessories, volume boosters, pressure boosters, solenoid valves, air lock, limit switches, hand wheel, positioners: Need, applications, types, effect on performance of control valve.
Actuators: Types, construction, advantages, disadvantages and applications of spring and diaphragm, piston cylinder (power cylinder), pneumatic, hydraulic, electric, electro-hydraulic and smart actuators. Design of spring and diaphragm actuators.
Auxiliary process components: Feeders, dampers, hazardous area classification.

B. Valve accessories like reversing relay and electro-pneumatic converter. Hydraulic and smart actuators, intrinsic safety and its components.
<table>
<thead>
<tr>
<th>Text Books</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Reference Books</th>
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<tbody>
<tr>
<td>2. “Tuning of industrial control systems”, ISA.</td>
</tr>
<tr>
<td>3. “Control valve Handbook”, ISA.</td>
</tr>
</tbody>
</table>
IC30104:: PLC, DCS AND SCADA

Credits: 03
Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know fundamentals of PLC and DCS.
- Programming in PLC and DCS.
- Know Hardware structure of PLC and DCS.
- Mapping with PEOs: IV (f)

Unit I  (8+1 Hrs)
Introduction to PLC

B. Choosing PLC for application, Types and Specifications of PLC

Unit II (7+2 Hrs)
PLC Programming and Interfacing

A. PLC programming: Development of Relay Logic Ladder Diagram, Introduction to PLC Programming, Programming devices and languages as per IEC 61131-3 like IL, ST, FBD, CFC, SFC, PLC Timers and Counters, Installation and Troubleshooting. PLC Interfacing: PID Control using PLC, PID instruction. PLC Interface to Hydraulic/Pneumatic circuits, solid-state devices, Need of interfacing.
B. PLC Selection, PLC interface to temperature control loop.

Unit III (8+1 Hrs)
SCADA System
A. SCADA Concept of SCADA systems, Programming techniques for: Creation of pages, Sequencing of pages, Creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management, reporting of events and parameters. Comparison of different SCADA packages.

B. Application Development using SCADA system.

Unit IV (7+2 Hrs)
Introduction to DCS

A. DCS Introduction, Location of DCS in Plant, functions, advantages and limitations, Comparison of DCS with PLC, DCS components/ block diagram, Architecture, Functional requirements at each level, Database management.

B. Latest trends and developments of DCS, DCS Specification.

Unit V (8+1 Hrs)
DCS Hardware

A. Layout of DCS, Controller Details, Redundancy, I/O Card Details, Junction Box and Marshalling Cabinets, Operator Interface, Workstation Layout, different types of control panels, types of Operating Station, Programming as per IEC 61131-3, Advantages, Overview of Programming Languages, Device Signal Tags, Configuration, Programming for Live Process.

B. Power supply cards details, various display configurations.

Text Books


Reference Books

IC30106:: BIOMEDICAL INSTRUMENTATION

<table>
<thead>
<tr>
<th>Credits: 03</th>
<th>Teaching Scheme: - Theory 3 Hrs/Week</th>
</tr>
</thead>
</table>

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- To study different types of electrodes used in bio-potential recording.
- To understand how to measure various biochemical and nonelectrical parameters of human system.
- Mapping with PEOs: I (b)

Unit I
Bioelectric signals
(8+1 Hrs)
A. Bioelectric signals (ECG, EMG, EEG, EOG & ERG) and their characteristics, Bio electrodes, electrodes tissue interface, contact impedance, effects of high contact impedance, types of electrodes, electrodes for ECG, EEG and EMG, Patient monitoring systems.
B. Studying of amplifiers, filter required for biomedical systems.

Unit II
Cardiovascular system
(8+1 Hrs)
A. Cardiac Cycle, ECG Theory, Electrocardiograph, Phonocardiograph, Indicator dilution method; blood pressure measurement techniques, blood flow measurement, Introduction to Cardiac Pacemakers, Defibrillators.
B. ECG amplifier designing, automation of BP measurement technique.

Unit III
Nervous System
(8+1 Hrs)
A. Structure of neuron, central nervous system, Electroencephalograph, Evoked response.
B. Designing of EEG amplifier and filters for EEG, Frequency analysis of EEG.

Unit IV
Respiratory system
(8+1 Hrs)
A. Natural Process of Breathing, Spirometry and Respiratory gas analyzers.
Clinical Lab Instrumentation: Blood cell counter, Method of Cell counting Coulter Counters; Automatic recognition and differential counting of cells.
B. Designing of Spirometer and analysis of respiration signal.

Unit V
Biomedical system Design

A. Transducers for Biomedical Application: Resistive transducers- muscle force and Stress (Strain gauge), Spirometry (Potentiometer), humidity, Respiration (Thermistor), Inductive Transducers-Flow measurements, muscle movement (LVDT) Capacitive Transducers-Heart sound measurement, Pulse pick up. Photoelectric Transducers - Pulse transducers, Blood pressure, oxygen Analyses Piezoelectric Transducers - Pulse, ultrasonic blood flowmeter. Chemical Transducer - Ag-AgCl (Electrodes, PH electrode).

B. Developing a system for Measurement of heart rate, Blood pressure, Temperature, Respiration rate.

Text Books

Reference Books
1. “Medical Instrumentation application and design”, John G. Webster, Wiley Publications.
IC31102 :: OPERATING SYSTEMS

Credits: 03  |  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: After the completion of the course, students will be able to
- Understand the working of operating systems of computer as a resource manager.
- Mapping with PEOs: I (j)

Unit I  (8+1 Hrs)
Overview of operating system
A. Introduction to operating systems, Computer System Structures, Operating System structures.
Process: concept, scheduling, operations on Process, Inter process communication, Threads: Overview, multiple threads.
B. Comparison of different process scheduling algorithms used in various operating systems.

Unit II  (6+1 Hrs)
CPU scheduling, Deadlocks and Process Synchronization
Process Synchronization: Critical section, Semaphores, pipes, classical problems of Synchronization.
B. Problems on CPU scheduling and comparison of different CPU scheduling algorithms used in various operating systems.

Unit III  (8+1 Hrs)
Storage Management
A. Memory management: Swapping, contiguous memory allocation, paging, segmentation, segmentation with paging.
Virtual memory: Demand paging, page replacement, allocation of frames, thrashing.
B. Study of different page replacement algorithms.
Unit IV:  
File Systems, I/O Systems, and Mass Storage  

A. File System Interface: File concept, access methods, directory structure;  
File System Implementation: file system structure, allocation methods, free space management, recovery  
I/O systems: overview, I/O hardware, Application I/O interface, kernel I/O sub systems,  
Mass Storage structure: disk structure, disk scheduling.  
B. Comparison of different disk scheduling for different operating systems.

Unit V  
Protection and Security  

A. Protection: goals and domain of protection, access matrix,  
Security: security problem, user authentication, program threats, systems threats, securing systems and facilities, intrusion detection, cryptography, computer security classification.  
B. Comparison of different protection and security used in various operating systems.

Text Books  

Reference Books  
IC30202 :: PROCESS LOOP COMPONENTS

| Credits: 01 | Teaching Scheme: 1Hr/Week |

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know the fundamentals of process loop components.
- Select suitable component for given applications.
- Check performance specifications of component.
- Mapping with PEOs: IV (f)

List of Tutorials:

1. Study of selection criteria of feedback and feed-forward control systems.
2. Development of P&ID for process loops.
3. Reading of P&ID and understand it.
4. Identification of different variables from the process loop.
5. Collecting specifications and installation schemes of Electronic DPT for flow and level measurement application.
7. Solving numericals on continuous control modes.
8. Solving numericals on PID control modes.
9. Solving numericals on control valve design.
10. Collecting specifications of control valve and annunciators.
11. Solving numericals on actuator design.
12. Study of auxiliary process components.
### Text Books


### Reference Books

2. “Tuning of industrial control systems”, ISA.
3. “Control valve Handbook”, ISA.
**IC30204 :: PLC, DCS AND SCADA**

<table>
<thead>
<tr>
<th>Credits:</th>
<th>01</th>
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</thead>
<tbody>
<tr>
<td>Teaching Scheme:</td>
<td>1Hr/Week</td>
</tr>
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</table>

**Prerequisites:** Nil

**Objectives:** Upon completion of this tutorials, student should be able to:
- Know the Programming languages for DCS and DCS.
- Interfacing technique for PLC and DCS.
- Know the SCADA system.
- Mapping with PEOs: IV (f)

**List of Tutorials :**

1. Study of different PLC and their specification.
2. Study of installations and troubleshooting of PLC.
3. Solving example by LD and ST programming in PLC.
4. Solving example by timer and counter in PLC.
5. Solving example using SFC programming in PLC.
7. Develop a one application on SCADA system.
8. Study different type of DCS and their latest trends.
9. Selection steps of DCS for industrial automation.
10. Study of specification list for DCS.
11. Solving different examples by FBD in DCS.
12. Develop master-slave configuration using DCS.
13. Study of Alarm management system in DCS.
14. Study of different I/O cards in DCS.
15. Develop communication between DCS and stand-alone controller.
16. Study of Hardware structure of DCS.
Text Books


Reference Books

**IC30302 :: PROCESS LOOP COMPONENTS & BIOMEDICAL INSTRUMENTATION**

| Credits: 01 | Teaching Scheme: - Laboratory 2 Hrs/Week |

**Prerequisites:** Nil

**Objectives:** Upon completion of this course, student should be able to:
- Know the fundamentals of process loop components.
- Select suitable component for given applications.
- Check working of biomedical equipments.
- Mapping with PEOs: I, IV (f)

**List of Practicals:** Students should perform at least 6 practicals each from practical no. 1 to 9 and 10 to 20.

1. Study and calibration of current to pressure converter.
2. Study and calibration of pressure to current converter.
3. Demonstration and study of square root extractor.
4. Demonstration and study of alarm annunciator.
5. Study of analog two–wire and SMART temperature transmitter.
6. Study of D.P. transmitter and calibrate it using hand-held configurator for level.
7. Tuning of PID controller for temperature control loop.
8. Study of control valve cut section and plot its installed characteristics.
10. Study of ECG Recorder.
11. Study of Blood Pressure instrument.
12. Study of Phonocardiograph.
15. Study of Pulse Oxymeter.

17. Study of Electrodes.
18. Designing of QRS detector.
19. Frequency analysis of ECG signal.
20. Frequency analysis of EEG signal.

**Text Books**


**Reference Books**

2. “Tuning of industrial control systems”, ISA.
3. “Control valve Handbook”, ISA.
IC30304 :: PLC, DCS AND SCADA

Credits: 01  Teaching Scheme: - Laboratory 2 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:

- Know the operation of DCS and PLC.
- Design control strategy for process control system.
- Apply advanced control strategies to plant control system.
- Mapping with PEOs: IV (f)

List of Practicals: Students should perform at least 12 practicals from given list.

1. Development of Ladder program for simple on-off applications.
2. Development of Ladder program for Timing and counting applications.
3. Use of advanced instructions for application in PLC.
4. Development of SFC Program for batch applications.
5. Structure Text Programming for given process.
6. Creating and Configuring a Project and tags in SCADA.
8. Programming of HMI interfacing with PLC.
10. Develop simulate programming using FBD in Delta –V.
12. Tag Assignments to Field Devices in DCS.
13. DCS based PID control for temperature loop.
14. Communicate PLC with SCADA & DCS.
16. Develop serial communication using Delta-V DCS.
**Text Books**

**Reference Books**
IC37302 :: PROJECT STAGE - I

Credits: 01

Teaching Scheme: Laboratory 1 Hr/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:

- Understand his/her topic of interest.
- Understand the work has been carried out in his topic.
- Develop his/her oral communication and presentation skills.
- Mapping with PEOs: I, II (i)

The Project Guides will be allotted in the beginning of this Semester based on the Area of Interest of the Students. Students in consultation with the guide should submit a one page report with Title of the Project (tentative) and a brief abstract.

During this stage problem identification, literature survey should be completed. A brief talk on this work must be presented during the semester. This is to be evaluated by the Department Committee constituted for the purpose.

The students should periodically meet their guide and maintain a log book with periodic milestones achieved.
### B. E. (Honors) Structure: FF 653, Issue No. 3, Rev 01 Dated 02/04/2011

<table>
<thead>
<tr>
<th>Sub. No.</th>
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<td>IC28101</td>
<td>Chemical and Environmental Measurements</td>
<td>3</td>
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<td>S2</td>
<td>IC38101</td>
<td>Error Analysis with applications in Engineering</td>
<td>3</td>
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<td>S3</td>
<td>IC38102</td>
<td>Bio-Signal Processing</td>
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<td>S4</td>
<td>IC48101</td>
<td>Statistical Signal Processing</td>
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<tr>
<td>S5</td>
<td>IC48102</td>
<td>Advanced Control Systems</td>
<td>3</td>
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<tr>
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<td>Credits for Lab Courses (Group Selection)</td>
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<tr>
<td><strong>Total</strong></td>
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</tbody>
</table>
IC28101 :: CHEMICAL AND ENVIRONMENTAL MEASUREMENTS

Credits: 03  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know the fundamentals of sensors and transducers.
- Select suitable sensor for given applications.
- Can build suitable measurement technique.
- Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)
Introduction to Analytical Instrumentation

A. Introduction to Chemical Instrumental Analysis, advantages over classical methods, classification, various units used in chemical analysis.
B. Introduction to Electro analytical methods, potentiomtery, voltametry, coulonimetry.

Unit II  (7+2 Hrs)
Spectrometric Methods-I

A. Laws of Photometry, UV-visible instrument component, photo colorimeters, single and double beam' instruments, various types of UV-visible spectrophotometers.
B. Atomic absorption spectrophotometer: Principle, working, hollow cathode lamp, atomizer, back ground correction.

Unit III  (8+1 Hrs)
Spectrometric Methods-II

A. IR spectroscopy: Principle, IR sources, IR detectors, dispersive and Fourier Transform IR spectroscopy.
B. Atomic Emission Spectroscopy: Principle, types, Flame photometer, DC arc and AC Arc excitation, plasma excitation.

Unit IV  (8+2 Hrs)
Spectrometric Methods-III and Miscellaneous Instruments

A. Spectrofluorimeters, Raman effect, Raman spectrometer, Gas analyzers: CO, C02, Hydrocarbons, 02, NOx.
B. Nuclear Magnetic Resonance (NMR) spectrometry.

Unit V (8+1 Hrs)
Separative Methods

A. Mass Spectrometer (MS): Principle, ionization methods, mass analyzer types – magnetic deflection type, time of flight, quadruple, double focusing, detectors for MS. Water Quality Monitoring, Soil and sediment testing, Air Monitoring.

Part B. Non Destructive Testing: Metal Detector, Non Metal Detector.

Text Books

Reference Books
IC38101 :: ERROR ANALYSIS WITH APPLICATION IN ENGINEERING

Credits: 03  |  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know the fundamentals of error.
- Understand importance of error in engineering.
- Study some error analyzing techniques.
- Mapping with PEOs: I, II (a)

Unit I (8+1 Hrs)
Basic characteristics of error distribution; histograms

A. Histograms, The average of a sample of measurements, Dispersion measures in error analysis, Cumulative frequency distribution, Examples of empirical distributions, Parameters obtained from the measured data and their theoretical values.

B. Specifications of sensors, static and dynamic characteristics calculations, selection criteria for sensors.

Unit II (8+2 Hrs)
Sample points, random variables, and probability

A. Probability and random variables, cumulative distribution function, the probability density function, Moments. Deterministic functions of random variables, Some other one-dimensional distributions: normal distribution, binomial distribution, multinomial distribution, Poisson distribution.

B. Numerical on normal distribution.

Unit III (8+1 Hrs)
Linear regression

A. Linear regression of experimental observations, The method of least squares for determining the linear regression line, The method of moments for determining the linear regression line, Linear correlation between experimentally determined quantities.

B. Computation of Linear regression parameters for a data using MATLAB.


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Unit IV (8+2 Hrs)

Estimation techniques

A. Mean square, ordinary least squares, generalized least squares, weighted least squares, and iteratively reweighted least squares. Maximum likelihood estimation.

B. Robust estimation techniques, e.g. $\alpha$-trimmed mean approach.

Unit V (8+1 Hrs)

Case studies on error analysis and estimation

A. Application of error: measurement system, estimation in adaptive noise control, determining system function (polynomial approximation), image processing. Errors in a Flow Rate Measurement.

B. Study the effect of Sampling the flow data.

Text Books


Reference Books

IC38102: BIOMEDICAL SIGNAL PROCESSING

<table>
<thead>
<tr>
<th>Credits: 03</th>
<th>Teaching Scheme: Theory 3 Hrs/Week</th>
</tr>
</thead>
</table>

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know the fundamentals of biomedical signal detection and estimation.
- Mapping with PEOs: I, II (a)

Unit I (8+1 Hrs)
Spectrum estimation: Non Parametric Estimation

B. Problem solving and Matlab implementation for spectral estimation.

Unit II (8+2 Hrs)
Parametric Estimation

B. Problem solving and Matlab implementation for spectral estimation.

Unit III (8+1 Hrs)
Cardio vascular applications

B. Matlab programming for Heart Rhythm representation - Spectral analysis of heart rate variability and interaction with other physiological signals, Event detection in ECG, detection fetal heartbeats during labor, cancelling of maternal ECG during labor.
Unit IV (8+2 Hrs)  
**Neurological Applications**

A. The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications - Epilepsy, sleep disorders, brain computer interface. Modeling EEG - linear, stochastic models – Nonlinear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis, Spectral analysis of EEG using AR modeling.

B. Detection of spikes and different waveform from EEG signal, Use of spectral analysis by a DFT for differentiating between brain diseases, adaptive filtering of ocular artifacts from human EEG.

Unit V (8+1 Hrs)  
**Analog signal processing**

A. Simple signal conversion system, conversion requirement for biomedical signal, signal conversion circuits, Data acquisition system development, Arrhythmia and Ambulatory Monitoring system – ST/AR algorithm, Data compression techniques.

B. Design of a Heart rate meter and signal analysis of it.

---

**Text Books:**

3. "Biomedical Signal Analysis", Rangaraj M. Rangayyan

**Reference Books:**

IC48101 :: STATISTICAL SIGNAL PROCESSING

<table>
<thead>
<tr>
<th>Credits: 03</th>
<th>Teaching Scheme: Theory 3 Hrs/Week</th>
</tr>
</thead>
</table>

**Prerequisites:** Students should have knowledge of basic Fourier analysis, linear algebra, and probability and statistics.

**Objectives:** Upon completion of this course, student should be able to:
- Understand the algorithm for random signal analysis.
- Mapping with PEOs: I, II (a)

**Unit I** (8+1 Hrs)
Discrete-Time Random Processes
B. Problems related to above contents

**Unit II** (7+2 Hrs)
Signal Modeling
B. Problems related to above contents

**Unit III** (8+1 Hrs)
Optimum Filters
A. Introduction, The FIR Wiener Filter, The IIR Wiener Filter, Discrete Kalman Filter
B. Problems related to above contents

**Unit IV** (7+2 Hrs)
Spectrum Estimation
B. Problems related to above contents.
Unit V (8+1 Hrs)
Adaptive Filtering
A. Introduction, FIR Adaptive Filters, Adaptive Recursive Filters, Recursive Least Squares.
B. Problems related to above contents.

Text Books

Reference Books
IC48102 :: ADVANCED CONTROL SYSTEMS

Credits: 03  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Control systems/Process Control

Objectives: Upon completion of this course, the students will be able to:
- Understand nonlinear systems behaviors
- Stability analysis of nonlinear systems
- Knowledge of basic concepts adaptive control systems
- Mapping with PEOs: I, II (a)

Unit I: (8+1Hrs)
Basic concepts of Non-linear systems:
A. Types of non-linearity, typical examples like Saturation, dead zone etc, typical examples backlash, hysteresis etc. Describing functions for different types of nonlinearity, singular points, Saddle points, Limit cycles, Vortex points, practical examples of limit cycles, Liberalization of typical system, Need for model reduction, Dominant pole concept, Model reduction via partial realization
B. Time moment matching and pade approximation, Hankel norm model reduction

Unit II: (8+1Hrs)
Stability of Non-linear systems
A. Stability concepts - Equilibrium points - BIBO and asymptotic stability, Lyapunov Theory, Definitions (Stability and Functions), Direct method of Lyapunov, Application to non-linear problems Stability, analysis by describing function method -jump resonance Frequency domain stability criteria
B. Popov's method and its extensions

Unit III: (8+1Hrs)
Model reference adaptive systems
A. Different configurations and classifications of MRAC, Mathematical description - Direct and indirect model reference adaptive control, MIT rule for continues time MRAC systems, Lyapunov approach and hyper stability approach for continuous time MRAC systems, Lyapunov approach and hyper stability approach for discrete time MRAC
systems, Multivariable systems
B. Stability and convergence studies of MRAC.

Unit IV:
(8+1Hrs)

Self tuning regulator
A. Different approaches to self-tuning, Recursive parameter estimation, Implicit and explicit STR, LQG self-tuning. Convergence analysis, Minimum variance and pole assignment
B. Approaches to multivariable self-tuning regulators

Unit V:
(8+1Hrs)

Advances in self tuning regulators and its analysis
A. Recent trends in self-tuning, Robustness studies, Multivariable systems, Model updating, General-purpose adaptive regulator, Application to Process control components and systems
B. Case study of Industrial Applications

Text-Books:

Reference Books:
IC48301:: CREDITS FOR LAB COURSES

<table>
<thead>
<tr>
<th>Composition for Selection of 5 Credits for Honors / Minor Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(A) Comprehensive Viva Voce - Compulsory at the end of Sem. VIII – 1 Credit</strong></td>
</tr>
<tr>
<td><strong>(B) Elective Component</strong></td>
</tr>
<tr>
<td>a. Laboratory courses – Maximum Credits - 2</td>
</tr>
<tr>
<td>( for award of 1 Credit the lab course would have a teaching scheme of 2 Hrs. / week and a plan of 12 practicals) . The credit to be awarded as per the ISA and ESA guidelines for the compulsory lab courses.</td>
</tr>
<tr>
<td>b. Research publication – Maximum Credits – 1</td>
</tr>
<tr>
<td>( Research Publication in a Magazine / Transaction / Journal as decided by the honors / minor co-ordinator)</td>
</tr>
<tr>
<td>c. Seminar - Maximum Credits – 1</td>
</tr>
<tr>
<td>(Seminar to be given on a topic consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors / minor co-ordinator. The assessment and evaluation scheme would as per the guidelines used for Technical Seminar at UG level by respective Dept.)</td>
</tr>
<tr>
<td>d. Honors / Minors Project – Maximum Credits – 2</td>
</tr>
<tr>
<td>(Project Topic and Scope, its progress and final assessment consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors / minor co-ordinator. The assessment would as per the guidelines and evaluation scheme used for Project Work at UG level by respective Dept.)</td>
</tr>
<tr>
<td>e. Industrial Training – Maximum credits – 4</td>
</tr>
<tr>
<td>( An Industrial Training in an Industry identified by the student, approved by the honors / minor co-ordinator &amp; Head of Department. The assessment would as per the guidelines and evaluation scheme used for Industrial Training at UG level by respective Dept.)</td>
</tr>
</tbody>
</table>

**Note:**

- a. 4 Credits would be awarded to the students for a complete 12 Week Industrial Training and meeting with the assessment and evaluation requirements
- b. Provision can be made for the students unable to procure a 12 week Industrial Training. A 4 week or 8 week Industrial Training may also be offered. 2 credits will be awarded for 8 week Industrial Training and 1 Credit would be awarded to the students for a 4 Week Industrial Training, meeting with the assessment and evaluation requirements
- c. No Industrial Training less than 4 weeks be considered for award of 1 Credit
- d. No cumulative addition of Industrial Training period would be considered for award of credits

**The student is expected to earn 1 Credit from Part (A) and remaining 4 Credits from Part (B)**
Minor In
Instrumentation &
Control Engineering
B. E. (Minor in Instrumentation and Control) Structure:  FF 653,

Issue No. 3, Rev 01 Dated 02/04/2011

<table>
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<th>Sub. No.</th>
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<th>Subject Name (Minor)</th>
<th>Teaching Scheme (Hrs/wk)</th>
<th>Credits</th>
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<tr>
<td>S1</td>
<td>IC29101</td>
<td>Fundamentals of Instrumentation</td>
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<td>S2</td>
<td>IC39101</td>
<td>Sensors and Measurements</td>
<td>3 0 0</td>
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<tr>
<td>S3</td>
<td>IC39102</td>
<td>Process Loop Components</td>
<td>3 0 0</td>
<td>3</td>
</tr>
<tr>
<td>S4</td>
<td>IC49101</td>
<td>Microcontroller for Mechanical Systems</td>
<td>3 0 0</td>
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<tr>
<td>S5</td>
<td>IC49102</td>
<td>Mechatronics</td>
<td>3 0 0</td>
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</table>
IC29101:: FUNDAMENTALS OF INSTRUMENTATION

Credits: 03 Teaching Scheme: - Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know about standards and system design concept.
- Mapping with PEOs: I, II (a)

Unit I (8+1 Hrs)
Measurement and measuring systems:
A. Significance of Measurement, Methods of measurement, classification of Instruments, Elements of generalized measurement system, Static Characteristics of Instruments ,Error analysis: True Value, Error (Gross, Systematic and Random), Types of error, statically treatment of data, Arithmetic Mean, standard deviation, variance, Normal or Gaussian curve of errors, distribution-normal, binomial, passions, rectangular.
B. Interpolation and curve fitting, lognormal, exponential, ch-squared distribution and Problem solving on above topics

Unit II (8+1 Hrs)
Dynamic Characteristics of Instruments
A. Dynamic analysis of Measurement system, Mathematical model of a system, Linear and nonlinear system, analogies between mechanical and electrical thermal system, mechanical system, pneumatic system, Transfer function, order of system, step, Ramp, impulse response of system, correlation between time and frequency response.
B. Problem solving on above topic

Unit III (8+1 Hrs)
Introduction To Analog And Digital Circuits
A. Diode, Transistor, applications of diode and transistor, op Amp and their linear applications (differential Instrumentation amplifiers), filters, Multivibrators (555 Timer IC and its applications). Introductions to number system and logic gates, counters and timer applications of digital ICs. ADC and DAC basics and selection criteria. Multiplexor and Demultiplexure introduction and applications.

B. Design of speed measurement, frequency counter.

Unit IV  
Display And Recorders Instruments  
(8+1 Hrs)

A. Seven segment display, LED, LCD, graphical display, digital frequency counter 
Necessity of recorder, analog recorder, digital recorder. 
B. y-t recorder, x-y recorder.

Unit V  
Standards And Calibration  
(8+1 Hrs)

B. Study of calibration procedure of other process and mechanical parameter.

Text Books:

Reference Books 
IC39101 :: SENSORS AND MEASUREMENTS

Credits: 03  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know the fundamentals of sensors and transducers.
- Select suitable sensor for given applications.
- Can build suitable measurement technique.
- Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)
Displacement Measurement
A. Transducer definition, classification, and performance characteristics.
Resistive: Potentiometer and its types, loading effect, sensitivity, piezo-resistive, equivalent circuits, charge and voltage sensitivity.
Inductive: LVDT, RVDT, variable, reluctance, self-inductance and mutual inductance.
Capacitive: single plate, differential capacitance cell and measurement circuits.
Digital transducers: encoders – types of translational and rotary encoders.
Proximity sensors: inductive, capacitive, optical, ultrasonic, hall-effect and magnetic.
Flapper nozzle: sensitivity, characteristics, its applications in air gauging,
Thickness measurement - magnetic, dielectric, LASER, capacitive, ultrasonic and LVDT.
B. Specifications of sensors, static and dynamic characteristics calculations, selection criteria for sensors.

Unit II  (7+2 Hrs)
Velocity and Speed Measurement
A. Mechanical revolution counters, hand held, vibrating reed, centrifugal force, stroboscopes, toothed rotor, eddy current, capacitive tachometer, electromagnetic transducers (moving coil, moving magnet), AC and DC tachometers.
B. Hall effect proximity pickup, capacitive, photoelectric, photo-reflective, pulse counting method, Doppler Laser and radar type.
Unit III  
**Acceleration, Vibration, Shock and Jerk Measurement** (8+1 Hrs)

A. Acceleration measurement: seismic, potentiometer, angular accelerometer, variable reluctance, eddy current proximity sensor. 
Vibration, shock and jerk measurement: vibrometer, vibration exciters, jerk meter. 
Vibrometer, Vibration exciters, Jerk meter. 

B. Capacitive, strain gauge, LVDT, piezoelectric, calibration of accelerometers.

Unit IV  
**Strain, Force, and Torque Measurement** (7+2 Hrs)

A. Strain measurement: principle, strain gauge, types, gauge factor, gauge wire properties, rosettes and measurement circuits. 
Force measurement: basic methods of force measurement, strain gauges, piezoelectric. 
Torque measurement: In-line rotating and stationery, torsion bar. 
Shaft power measurement: belt, gear dynamometer, absorption dynamometer types. 
Weight measurement: load cells-electromagnetic, vibrating string, magneto-strictive, magneto-elastic and cantilever beam.

B. Strain measurement: strain gauge mounting and compensation circuits. 
Force measurement: using LVDT and vibrating wire type. 
Torque measurement: inductive, photoelectric, proximity sensor and strain gauge. 
Shaft power measurement: nstantaneous and alternator power measurement. 
Weight measurement: LVDT, strain gauge, inductive, piezo-electric principles. 
Comparison of pneumatic, hydraulic and electronic Load cell.

Unit V  
**Robotic Sensors** (8+1 Hrs)

A. Robot sensors: position sensors, velocity sensors, acceleration sensors, force and pressure sensors, proximity sensors, light and infrared sensors, torque sensors, microswitches, range-finders, sniff sensors, vision systems, voice recognition devices, voice synthesizers, remote center compliance (RCC) device, touch and tactile sensors.

B. Advanced robotic sensors and their selection criteria and specifications.

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**Text Books**


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Reference Books
IC39102 :: PROCESS LOOP COMPONENTS

Credits: 03  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:

- Know the fundamentals of process loop components.
- Select suitable component for given applications.
- Can build suitable control strategy for application.
- Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)
Fundamentals of process control

A. Elements of process control loop: concept of process variables, set point, controlled variable, manipulated variable, load variable. Representation of process loop components using standard symbols (basics with reference to control loop).

Process Characteristics: Process equation, capacity, self – regulation, interacting types of disturbances, plant lags like measurement lag, control lag, process lag, distance/velocity lag (dead time) and transfer lag.

B. P & ID for process loops like temperature, flow, level, pressure, etc.

Unit II  (7+2 Hrs)
Transmitters and convertors

A. Introduction: Need of transmitter (concept of field area and control room area), need for standardization of signals, current, and voltage, and pressure signal standards, concept of live and dead zero. Types of transmitters: Two and four wire transmitters, electronic and pneumatic transmitters. Electronic Differential Pressure Transmitter: Types, installation, calibration setup, application of DPT for level and flow measurement, zero elevation and suppression. SMART: Comparison with conventional transmitter, block schematic. Converters: Difference between converter and transmitter, current to pressure converter. Auxiliary process components: Square root extractor, seals and snubbers.

B. Transmitter circuits, specifications of DPT and SMART transmitter, pressure to current converter, flow totalizer.
Unit III (7+1 Hrs)

Controllers


B. Multi-position control mode, types of processes versus control action, open loop process reaction method for tuning of controller and computing relay.

Unit IV (7+1 Hrs)

Control Valve

A. Necessity and comparison with other final control elements. Control valve terminology: rangeability, turndown, valve capacity, distortion coeff., AO, AC, fail-safe conditions, cavitation, flashing and noise, their effects and remedies. Control valve characteristics: (inherent and installed) Control valve classification, their construction, advantages, disadvantages and applications of globe, 3-way, diaphragm, rotary, ball, butterfly. Designing control valve for gas, vapor and liquid services: valve sizing by ANSI/ISA 75.01 std., valve capacity tests by 75.02, high temperature-pressure service valves.

B. Control valve construction: angle, needle and gate, control valve installation, selection and specifications.

Unit V (7+1 Hrs)

Control valve accessories and actuators


B. Valve accessories like reversing relay and electro-pneumatic converter. Hydraulic and smart actuators, intrinsic safety and its components.
Text Books
2. “Instrumentation for Process measurement and control”, N.A. Anderson

Reference Books
2. “Tuning of industrial control systems”, ISA.
3. “Control valve Handbook”, ISA.
IC49101 :: MICROCONTROLLER for MECHANICAL SYSTEMS

| Credits: 03 | Teaching Scheme: - Theory 3 Hrs/Week |

Prerequisites: Digital electronics.

Objectives: Upon completion of this course, student should be able to:
• Learn to program a microcontroller for mechanical systems.
• Mapping with PEOs: I, II (a)

Unit I (8+1 Hrs)
Introduction to microcontrollers (MCS51 family)
A. Overview and features, on chip and external memory map, Memory interfacing concepts, Port Structure, I/O interfacing concepts, I/O expansion, Instruction set, reset circuit and timing details.

Unit II (8+1 Hrs)
Architecture Details of MCS-51
A. Interrupt Structure, Timers and Counters, Generating Software and Hardware Delays, Serial Communication, Power Down and Idle mode.
B. Writing programs for interrupts, timers, counters, generating delays, serial communication.

Unit III (8+1 Hrs)
Interfacing of devices to MCS-51
A. Interfacing of Displays: LED (multiplexed and non-multiplexed), LCD. Interfacing of keyboards: Matrix type, Micro switches, Thumbwheel. Interfacing of ADC and DAC. Relay Interface. Stepper motor interface
B. Writing programs for interfacing circuits

Unit IV (8+1 Hrs)
Application of Microcontroller in Robotics
A. Robot movement for direction finding, robot arm movement, robot for spray painting,
material handling system.

B. Algorithms for the above systems.

Unit V (8+1 Hrs)

Application of Microcontroller

A. Speed measurement, vibration measurement, displacement measurement, temperature measurement, flow measurement.

B. Writing algorithm for the above applications.

<table>
<thead>
<tr>
<th>Text Books</th>
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<tbody>
<tr>
<td>1. 8051 Microcontroller and embedded systems – M. Mazidi, Pearson Higher Education</td>
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<tr>
<td>1. Programming and Customizing the 8051 microcontroller – Myke Predko, TATA McGraw Hill Edition</td>
</tr>
</tbody>
</table>
IC49102 :: MECHATRONICS

Credits: 03  
Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know the architecture and operation of mechatronics.
- Design control strategy for mechatronics applications.
- Apply advanced control strategies to mechatronics applications.
- Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)
Overview of Mechatronics

A. Introduction to mechatronics and design approach, block diagram, multidisciplinary scenario, system Interfacing, instrumentation and control systems, open loop and closed loop systems, microprocessor-based controllers and microelectronics, introduction to automation, micro- and nanotechnology. Mechanical components: springs (compression, extension, torsion, flat, leaf and motor spring), gears (spur, bevel, gear trains), mechanisms, bearings, gears, rack and pinion, ratchets, pawl, crank, sliders, cranks, cams, followers, chain and sprocket.

B. Open loop and closed loop systems, feedback and feed-forward control systems. Mechanical components like couplings, belt, chain, pulleys, Geneva wheels, four-bar linkages.

Unit II  (7+1 Hrs)
Hydraulic Components


B. Types of hydraulic oil, selection, hydraulic components like filters, piping, heat exchangers and motors.
Unit III (7+1 Hrs)

Pneumatic Components

A. Pneumatics: principle, block diagram, advantages, disadvantages, applications. Pneumatic components: pneumatic power Supply, types of pneumatic relay, FRL unit, pneumatic actuator (cylinders and air motors), pneumatic valves. Pneumatic circuits: development of pneumatic circuits using standard symbols, sequence diagram (step-displacement) for implementing pneumatic circuits, different pneumatic circuits like reciprocating, sequencing, anti-cycle repetition, block transfer, speed regulation, job sorting, electro-pneumatic circuits, etc.

B. Fluidic elements and its applications, development of pneumatic circuits, troubleshooting in pneumatic circuits.

Unit IV (8+1 Hrs)

Fundamentals of Robotics


B. Inverse kinematics programming of robots, Robot sensors: sensor characteristics, position sensors, velocity sensors, acceleration sensors, force and pressure sensors.

Unit V (7+1 Hrs)

Trajectory Planning

A. Path vs. trajectory, joint-space vs. Cartesian-space descriptions, basics of trajectory planning, joint-space trajectory planning. Cartesian-space trajectories, continuous trajectory recording. Robot actuators: characteristics of actuating systems, comparison of actuating systems, electric motors, microprocessor control of electric motors, magnetostrictive actuators, shape-memory type metals, speed reduction techniques.

B. Higher order trajectories. Robot sensors: proximity sensors, light and infrared sensors, torque sensors, microswitches.
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<tr>
<td>2. “Pneumatic Systems: Principles and Maintenance”, Majumdar,</td>
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<tr>
<td>1. “Industrial Hydraulic Technology Parker Motion &amp; Control, Training Department.</td>
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</table>
IC49301:: CREDITS FOR LAB COURSES

Composition for Selection of 5 Credits for Honors / Minor Course

(A) Comprehensive Viva Voce – Compulsory at the end of Semester VIII – 1 Credit

(B) Elective Component

a. Laboratory courses – Maximum Credits - 2
   (for award of 1 Credit the lab course would have a teaching scheme of 2 Hrs./week and a plan of 12 practicals). The credit to be awarded as per the ISA and ESA guidelines for the compulsory lab courses.

b. Research Publication – Maximum Credits – 1
   (Research Publication in a Magazine / Transaction / Journal as decided by the honors/ minor co-ordinator)

c. Seminar - Maximum Credits – 1
   (Seminar to be given on a topic consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors/ minor co-ordinator. The assessment and evaluation scheme would as per the guidelines used for Technical Seminar at UG level by respective Dept.)

d. Honors / Minors Project – Maximum Credits – 2
   (Project Topic and Scope, its progress and final assessment consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors/ minor co-ordinator. The assessment would as per the guidelines and evaluation scheme used for Project Work at UG level by respective Dept.)

e. Industrial Training – Maximum credits – 4
   (An Industrial Training in an Industry identified by the student, approved by the honors/ minor co-ordinator & Head of Department. The assessment would as per the guidelines and evaluation scheme used for Industrial Training at UG level by respective Dept.)

Note:

a. 4 Credits would be awarded to the students for a complete 12 Week Industrial Training and meeting with the assessment and evaluation requirements

b. Provision can be made for the students unable to procure a 12 week Industrial Training. A 4 week or 8 week Industrial Training may also be offered. 2 credits will be awarded for 8 week Industrial Training and 1 Credit would be awarded to the students for a 4 Week Industrial Training, meeting with the assessment and evaluation requirements

c. No Industrial Training less than 4 weeks be considered for award of 1 Credit

d. No cumulative addition of Industrial Training period would be considered for award of credits

The student is expected to earn 1 Credit from Part (A) and remaining 4 Credits from Part (B)
Minor In Industrial Automation
**B. E. (Minor in Industrial Automation) Structure:** FF 653, Issue No. 3,
Rev 01 Dated 02/04/2011

<table>
<thead>
<tr>
<th>Sub. No.</th>
<th>Sub. Code</th>
<th>Subject Name (Minor)</th>
<th>Teaching Scheme (Hrs/wk)</th>
<th>Credits</th>
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<tr>
<td>S1</td>
<td>IC29103</td>
<td>Programmable Logic Controller and HMIs</td>
<td>3 0 0</td>
<td>3</td>
</tr>
<tr>
<td>S2</td>
<td>IC39103</td>
<td>DCS and SCADA</td>
<td>3 0 0</td>
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<tr>
<td>S3</td>
<td>IC39104</td>
<td>Communication Protocols</td>
<td>3 0 0</td>
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<tr>
<td>S4</td>
<td>IC49103</td>
<td>Building Automation and Energy Audit</td>
<td>3 0 0</td>
<td>3</td>
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<tr>
<td>S5</td>
<td>IC49104</td>
<td>Mechatronics</td>
<td>3 0 0</td>
<td>3</td>
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<tr>
<td>P1</td>
<td>IC49311</td>
<td>Credits for Lab Courses (Group Selection)</td>
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<td><strong>Total</strong></td>
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<td>15 0 7</td>
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IC29103 :: PROGRAMMABLE LOGIC CONTROLLER & HMI

Credits: 03  
Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know the architecture and operation of mechatronics.
- Design control strategy for mechatronics applications.
- Apply advanced control strategies to mechatronics applications.
- Mapping with PEOs: I, II (a)

Unit I  
Fundamentals of Automation  
(8+1 Hrs)
B. Open loop and closed loop systems, feedback and feed-forward control systems. Concepts of Batch and continuous processes.

Unit II  
PLC Hardware  
(8+1 Hrs)
B. Specifications. PLC Interface to Hydraulic/Pneumatic circuits.

Unit III  
Pneumatic Components  
(8+1 Hrs)
A. Development of Relay Logic Ladder Diagram, Introduction to PLC Programming, Programming devices and languages as per IEC 61131-3 like IL, ST, FBD, CFC, SFC, PLC Timers and Counters, PLC Selection, Installation and Troubleshooting.
B. PLC Documentation.
Unit IV  
(8+1 Hrs)  
Advanced PLC instructions  

A. Advanced PLC instructions like, Program control, comparison, mathematical, logical, communication, shift registers, sequencers, data handling, advanced mathematical, PID Control using PLC, PID instruction, PID for temperature control loop.  

B. PLC programming for industrial applications using advanced instructions.  

Unit V  
(8+1 Hrs)  
Human-Machine Interface  

A. HMI programming. Need, working principle, functions and types of HMI. Programming techniques for Text display, Variable parameter display and setting alarm messages, Pages Generation, Sequence of pages, Graphic display, PLC-HMI communication.  

Part B. PLC-HMI communication.  

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IC39103:: DCS AND SCADA

Credits: 03  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:
- Know fundamentals of SCADA and DCS
- Know structure of SCADA and DCS
- Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)
Introduction to DCS

A. Automation: fundamentals of Industrial Automation, need and role of Automation, Evolution of Automation. DCS Introduction, Location of DCS in Plant, functions, advantages and limitations, Comparison of DCS with PLC, DCS components/ block diagram, Architecture, Functional requirements at each level, Database management, Latest trends and developments of DCS.

B. Types and Specifications of DCS.

Unit II  (7+2 Hrs)
DCS Hardware

A. Layout of DCS, Controller Details, Redundancy, I/O Card Details, Operator Interface, Workstation Layout, different types of control panels, types of Operating Station, Installation and Troubleshooting of DCS. PID Control using DCS, DCS Interface to Temperature control loop, solid-state devices, DCS Selection.

B. power supply detail, Junction Box and Marshalling Cabinets, Various Display Configurations
Unit III (8+1 Hrs)
DCS software

A. Programming as per IEC 61131-3, Advantages, Overview of Programming Languages, Device Signal Tags, Configuration, Programming for Live Process Programming devices and languages as per IEC 61131-3 like, FBD, SFC, DCS Timers and Counters, graphical interface in DCS. Use of analog control, Advanced control and energy metering FBD block.

B. Implement one application using DCS by FBD or SFC languages

Unit IV (7+2 Hrs)
Introduction to SCADA

A. Objectives of a SCADA, components of SCADA system, communication media for SCADA system, type of networking topology, different software system for SCADA, data acquisition mechanisms in SCADA. Handling of data during SCADA failures.

B. Specification list of different SCADA system with their manufacturer

Unit V (8+1 Hrs)
SCADA System

A. SCADA systems, Programming techniques for: Creation of pages, Sequencing of pages, Creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management reporting of events and parameters. Comparison of different SCADA packages.

B. Latest features of SCADA system

Text Books

Reference Books
IC39104 :: COMMUNICATION PROTOCOLS

Credits: 03  
Teaching Scheme: - Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: To analyze, specify, and debug industrial data communication systems, Industrial protocol, industrial networks in the instrumentation and control environment. Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)

Basic Communication systems

A. Basic Communication systems: Introduction, data communication principles, Modulation: PAM, PWM, PPM, ASK, FSK, PSK, TDM, FDM. Modems: basics, flow control, distortion, modulation techniques, radio modems, data compression techniques. Multiplexing: FDM, TDM communication modes, asynchronous and synchronous communication, transmission characteristics, error detection, data coding, UART, cabling basics, electrical noise and interference: noise, frequency analysis of noise, electrical coupling of noise, shielding, shielding performance ratios, cable ducting, cable spacing, earthing and grounding requirements, suppression techniques, filtering.

B. To study circuits of AM, VCO, PAM, PWM, PPM

Unit II (8+1 Hrs)

Serial data communications


B. Universal Serial Bus (USB)

Unit III (8+1 Hrs)

Serial data communications

A. ISO-OSI Model, Modbus, SPI, I2C, CAN communication protocol

B. Error diagnosis in Modbus Protocol, SPI, I2C, CAN, etc.
Unit IV (8+1 Hrs)
HART, Field bus and Profibus

B. Troubleshooting of HART, Field bus Protocol and Profibus communication protocol.

Unit V (8+1 Hrs)
Wireless Communication protocol

A. IrDA, Bluetooth, ZigBee, IEEE802.11, IEEE802.16
B. Study of GSM and GPRS network.

Text Books
1. “Practical Data Communications for Instrumentation and Control” John Park, Steve Mackay, Edwin Wright, ELESEVIER Pub.

Reference Books:
2. “Bluetooth Revealed; The insider’s guide to an open specification for global wireless communication”, Brent A. Miller, Chatschik Bisdikian, Pearson Education Asia.
5. User Manuals of Foundation Field bus, Profibus, Modbus, Ethernet, Devicenet, and Control net.
IC49103:: BUILDING AUTOMATION AND ENERGY AUDIT

Credits: 03  Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:

- Familiar with elements of building automation for homes, hotels, restaurants and industry.
- Know about HVAC system, security, access, alarm management and energy management systems
- Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)
Introduction of building automation


B. Current trend and innovations in building automation system.

Unit II  (8+1 Hrs)
HAVC system & FA system

A. Principles of HVAC system design and analysis. Different components of HVAC system like heating, cooling system, chillers, AHUs, compressors and filter units component and system selection criteria including room air distribution, fans and air circulation, humidifying and dehumidifying processes. Control systems and techniques. Fire control panels. Design considerations for the FA system. Concept of IP enabled Fire & Alarm system

B. piping and ducting design. Air quality standards

Unit III  (7+2 Hrs)
Access Control & Security System
A. Concept of automation in access control system for safety. Manual security system. RFID enabled access control with components like active, passive cards, controllers, and antennas, Biometric Intrusion alarm system, Components of Public Access (PA) System like speakers, Indicators, control panels, switches.
B. CCTV, IP cameras, broadband/LAN network Digital Video Recorder

Unit IV (8+1 Hrs)

Energy audit

A. Trends in energy consumption, Energy audit: evaluation of energy performance of existing buildings. Type of energy audit system. Type of Measurement or monitoring of energy, Energy audit objectives, one case study on energy audit.
B. Design consideration of EPBX system and its components.

Unit V (8+1 Hrs)

Energy Management System

B. Renewable energy sources: passive or active solar systems, geothermal systems,

Text Books

3. ‘Building Automation Beyond the Simple Web Server’, A. Budiardjo, Clasma Events, Inc.
IC49104 :: MECHATRONICS

Credits: 03  
Teaching Scheme: Theory 3 Hrs/Week

Prerequisites: Nil

Objectives: Upon completion of this course, student should be able to:

- Know the architecture and operation of mechatronics.
- Design control strategy for mechatronics applications.
- Apply advanced control strategies to mechatronics applications.
- Mapping with PEOs: I, II (a)

Unit I  (8+1 Hrs)
Overview of Mechatronics

A. Introduction to mechatronics and design approach, block diagram, multidisciplinary scenario, system Interfacing, instrumentation and control systems, open loop and closed loop systems, microprocessor-based controllers and microelectronics, introduction to automation, micro- and nanotechnology. Mechanical components: springs (compression, extension, torsion, flat, leaf and motor spring), gears (spur, bevel, gear trains), mechanisms, bearings, gears, rack and pinion, ratchets, pawl, crank, sliders, cranks, cams, followers, chain and sprocket.

B. Open loop and closed loop systems, feedback and feed-forward control systems. Mechanical components like couplings, belt, chain, pulleys, Geneva wheels, four-bar linkages.

Unit II  (8+1 Hrs)
Hydraulic Components


B. Types of hydraulic oil, selection, hydraulic components like filters, piping, heat exchangers and motors.


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Unit III  
**Pneumatic Components**  
*(8+1 Hrs)*

A. Pneumatics: principle, block diagram, advantages, disadvantages, applications.  
Pneumatic components: pneumatic power Supply, types of pneumatic relay, FRL unit,  
pneumatic actuator (cylinders and air motors), pneumatic valves, Pneumatic circuits:  
development of pneumatic circuits using standard symbols, sequence diagram (step-displacement) for implementing pneumatic circuits, different pneumatic circuits like reciprocating, sequencing, anti-cycle repetition, block transfer, speed regulation, job sorting, electro-pneumatic circuits, etc.

B. Fluidic elements and its applications, development of pneumatic circuits, troubleshooting in pneumatic circuits.

Unit IV  
**Fundamentals of Robotics**  
*(8+1 Hrs)*

A. Robot definition and classification, brief history of robotics, types of robots,  

B. Inverse kinematic programming of robots, Robot sensors: sensor characteristics,  
position sensors, velocity sensors, acceleration sensors, force and pressure sensors.

Unit V  
**Trajectory Planning.**  
*(8+1 Hrs)*

A. Path vs. trajectory, joint-space vs. Cartesian-space descriptions, basics of trajectory  
planning, joint-space trajectory planning. Cartesian-space trajectories, continuous trajectory recording. Robot actuators: characteristics of actuating systems, comparison of actuating systems, electric motors, microprocessor control of electric motors, magnetostrictive actuators, shape-memory type metals, speed reduction techniques.

B. Higher order trajectories. Robot sensors: proximity sensors, light and infrared sensors,  
torque sensors, microswitches.
### Text Books


### Reference Books

1. “Industrial Hydraulic Technology Parker Motion & Control, Training Department.
Composition for Selection of 5 Credits for Honors / Minor Course

(A) Comprehensive Viva Voce – Compulsory at the end of Sem VIII – 1 Credit

(B) Elective Component

a. Laboratory courses – Maximum Credits - 2
   (for award of 1 Credit the lab course would have a teaching scheme of 2 Hrs. / week and a plan of 12 practicals). The credit to be awarded as per the ISA and ESA guidelines for the compulsory lab courses.

b. Research publication – Maximum Credits – 1
   (Research Publication in a Magazine / Transaction / Journal as decided by the honors / minor co-ordinator)

c. Seminar - Maximum Credits – 1
   (Seminar to be given on a topic consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors / minor co-ordinator. The assessment and evaluation scheme would as per the guidelines used for Technical Seminar at UG level by respective Dept.)

d. Honors / Minors Project – Maximum Credits – 2
   (Project Topic and Scope, its progress and final assessment consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors / minor co-ordinator. The assessment would as per the guidelines and evaluation scheme used for Project Work at UG level by respective Dept.)

e. Industrial Training – Maximum credits – 4
   (An Industrial Training in an Industry identified by the student, approved by the honors / minor co-ordinator & Head of Department. The assessment would as per the guidelines and evaluation scheme used for Industrial Training at UG level by respective Dept.)

Note:

a. 4 Credits would be awarded to the students for a complete 12 Week Industrial Training and meeting with the assessment and evaluation requirements

b. Provision can be made for the students unable to procure a 12 week Industrial Training. A 4 week or 8 week Industrial Training may also be offered. 2 credits will be awarded for 8 week Industrial Training and 1 Credit would be awarded to the students for a 4 Week Industrial Training, meeting with the assessment and evaluation requirements

c. No Industrial Training less than 4 weeks be considered for award of 1 Credit

d. No cumulative addition of Industrial Training period would be considered for award of credits

The student is expected to earn 1 Credit from Part (A) and remaining 4 Credits from Part (B)
A) **Mid Semester Examination**

1. Students reporting in morning slot will have examination in morning slot. Those in evening slot will have examination in evening slot.
2. 20 multiple choice based questions to be attempted in 30 minutes x no. of theory courses i.e. 100 questions in 150 minutes for F.E., 80 questions in 120 minutes for S.E., T.E., B.E., M.E., 20 questions in 30 minutes for Honors, Minor, Fast Track, etc.
3. A scrambled mix of questions will be generated through software.
4. Mid Semester Examination will be based on Unit II & Unit III.
5. There will be one mark for each correct answer and (-) 0.25 marks for every wrong answer.
6. For a typical 3 hour Mid Semester Examination, first 15 minutes would be used for student attendance, record keeping, seat allocation, log in procedure if any, etc. Next 150 minutes for actual examination. A timer indicating time remaining to be provided by ERP. 15 minutes for processing & results.
7. A visual alarm / flash would be given 10 minutes before completion of 150 minutes as a warning. For auto generation of every theory course result out of 20 and dispatch of the marks on student mobile and mail ID as well as parent mail ID.
8. No repeat examination under any circumstances.
B) **Seminar – Conduct, Evaluation, etc.**

**Seminar – (T.E.- Semester I)**

1. Review – I: during Mid Semester Examination (Compulsory) as per the Academic Calendar.
2. Review – II: The last week of November (Optional)
3. For poor performing students identified by the examination panel, a second review to be taken. Review II optional for other students. For Review II, deduction of 10 marks will take place.
4. Seminar is an individual activity with separate topic and presentation.
5. Duration of presentation – 20 minutes
   Question and answer session – 10 minutes

**Seminar Evaluation Scheme:**

1. Attendance during Semester – 10 marks
2. Attendance during Seminar presentation self & peer – 10 marks
3. Relevance of Seminar topic – 10 marks
4. Timely Abstract submission – 10 marks
5. Literature review – 10 marks
6. Technical contents – 10 marks
7. Presentation – 25 marks
8. Question & answer Session – 15 marks

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100 marks

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C) **Equivalence**

For the courses belonging to 2008 structure counseling sessions for failure students will be arranged. The Head of Department will appoint faculty identified as subject experts as counselors. The previous examination scheme i.e.

Class Test – 10 marks  
T.A. through Home assignment – 10 marks  
A written paper MSE – 30 marks  
A written paper ESE – 50 marks

Will be followed. The entire processing based on 2008 structure related coding scheme will be followed. Counseling + Administration + Examination charges will be the basis for fees considered for such students.
D) Extra Credits

A student planning to take extra credits may be considered under following categories:

(a) A student carrying a backlog and re-registering for the previous course – Re-registration charges as applicable. Consideration of all courses registered for during that Semester of Academic Year for SPI calculation.

(b) Student planning to take extra courses as a fast track opportunity – Administration, processing and examination charges will be considered. In any case the student has to pay the college fees for four years. This fast track facility would enable the student to undergo an industrial training, an exchange programme, research contribution in I.I.T. under scheme such as KVPY without any academic compromises for credit transfer. The phasewise development and completion of project activity cannot be considered at an accelerated pace under fast track scheme. The registration under fast track is subject to having a CPI 8.0 or above and no backlog for consideration of registration to an additional course.

(c) Students opting for earning extra credits by selection of courses in addition to the courses prescribed by respective BOS which are single Semester activities and not the part of Honors / Minor scheme. Such students will be expected to pay charges equivalent to re-registration (proportionate credit based payment). The registration for such courses is subject to permission given by the Chairman BOS of the Board in the purview of which the subject is identified. Such permissions will be given based on meeting with prerequisite subject.

1. In any case (a), (b) or (c) the candidate cannot register for more than 8 credits.

2. A suitable reflection of completion of the said course will be made in the candidate’s Grade statement.

For part (c) a separate grade & GPA will be calculated. That GPA will not be clubbed with the other regular courses for SPI, CPI calculation.
## E) Home Assignment

A Home Assignment Calendar for Semester is prepared as under:

<table>
<thead>
<tr>
<th>Week No.</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Home Assignments</td>
</tr>
<tr>
<td>2</td>
<td>No Home Assignments</td>
</tr>
<tr>
<td>3</td>
<td>No Home Assignments</td>
</tr>
<tr>
<td>4</td>
<td>S1 / S2 – HA1</td>
</tr>
<tr>
<td>5</td>
<td>S3 / S4 / S5* - HA1</td>
</tr>
<tr>
<td>6</td>
<td>S1 / S2 – HA2</td>
</tr>
<tr>
<td>7</td>
<td>S3 / S4 / S5* - HA2</td>
</tr>
<tr>
<td>8</td>
<td>S1 / S2 – HA3</td>
</tr>
<tr>
<td>9</td>
<td>S3 / S4 / S5* - HA3</td>
</tr>
<tr>
<td>10</td>
<td>S1 / S2 – HA4</td>
</tr>
<tr>
<td>11</td>
<td>S3 / S4 / S5* - HA4</td>
</tr>
<tr>
<td>12</td>
<td>S1 / S2 – HA5</td>
</tr>
<tr>
<td>13</td>
<td>S3 / S4 / S5* - HA5</td>
</tr>
<tr>
<td>14</td>
<td>No Home Assignments</td>
</tr>
<tr>
<td>15</td>
<td>No Home Assignments</td>
</tr>
<tr>
<td>16</td>
<td>No Home Assignments</td>
</tr>
</tbody>
</table>

The Home Assignments will be based on the self study component i.e. part B of every theory course syllabus. The Saturday or last working day will be the default deadline for submission of Home Assignment of that week. For example by the Saturday ending Week No. 9, Home Assignment No. 3 for subject S3/ S4/ S5 (if applicable) must be submitted.

1. *S5 can be OE1 / OE2 / OE3 / Honors/ Minor / Re-registration category (a) / Category (b) / Category (c).

2. For subjects S1, S2, S3, S4 & S5 (if any), the composition of the Teacher Assessment marks will be as follows:
<table>
<thead>
<tr>
<th></th>
<th>S1, S2 with Tutorial</th>
<th>S3, S4, S5 without Tutorial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Assignment</td>
<td>30 marks</td>
<td>30 marks</td>
</tr>
<tr>
<td>Tutorial</td>
<td>30 marks</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>30 marks</td>
<td>30 marks</td>
</tr>
<tr>
<td>Attendance:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) &gt; 90%</td>
<td>10 marks</td>
<td>10 marks</td>
</tr>
<tr>
<td>(b) 75% to 90%</td>
<td>5 marks</td>
<td>5 marks</td>
</tr>
<tr>
<td>(c) &lt; 75%</td>
<td>0 marks</td>
<td>0 marks</td>
</tr>
<tr>
<td></td>
<td>100 marks converted to 15 marks</td>
<td>70 marks converted to 15 marks</td>
</tr>
</tbody>
</table>

**Explanation:**

1. Tutorials to be conducted with continuous assessment throughout the Semester. Final assessment out of 30 marks for Tutorial.
2. Class Test to be conducted during a regular theory class within the time period mentioned in the Academic Calendar.
3. Class Test marks are to be entered immediately as mentioned in Academic Calendar.
4. Attendance percentage to be calculated at the end of Semester after completing all lectures as per the lesson plan.
F) **Mini Project**

Teaching Scheme: Theory – 0 ; Tutorial – 0 ; Laboratory – 2 Hrs / week

For F.E., S.E. & T.E. students in every Semester a Mini Project be carried out. The objectives behind the Mini Project are:

1. Scope for creativity  
2. Hands on experience  
3. Academic occupancy

Mini Project will be based on all subjects of that Semester except GP.

1. The Semester Mini Project will be for a group of 3 to 5 students. Head of Department to appoint Mini Project Guides. 2 credits will be awarded to the candidate after the viva voce and project demonstration at the End of Semester.
2. Group formation, discussion with faculty advisor, formation of the Semester Mini Project statement, resource requirement, if any should be carried out in the earlier part of the Semester. The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.

The Assessment Scheme will be:

- (a) Continuous Assessment 50 marks
- (b) End Semester 50 marks

---------------
100 marks
-------------
G) **Project Stage I Evaluation**

The project activity is broken in 3 stages:

The Project Stage I will be in T.E Semester II irrespective of student module. The evaluation of Project Stage I will be as follows:

<table>
<thead>
<tr>
<th>Evaluation Area</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group formation &amp; attendance / reporting to guide</td>
<td>20</td>
</tr>
<tr>
<td>Topic finalization / Statement</td>
<td>20</td>
</tr>
<tr>
<td>Literature Survey</td>
<td>20</td>
</tr>
<tr>
<td>Abstract</td>
<td>20</td>
</tr>
<tr>
<td>Presentation</td>
<td>20</td>
</tr>
</tbody>
</table>

Project Stage II and Project Stage III evaluations will be based on Department specific norms.
H) **Composition for Selection of 5 Credits for Honors / Minor Course**  
*(Applicable for B11 and A11 Patterns)*

(A) **Comprehensive Viva Voce** – Compulsory at the end of Semester VIII – 1 Credit

(B) **Elective Component**

   a. **Laboratory courses** – **Maximum Credits - 2**  
      (for award of 1 Credit the lab course would have a teaching scheme of 2 Hrs. / week and a plan of 12 practicals). The credit to be awarded as per the ISA and ESA guidelines for the compulsory lab courses.

   b. **Research publication** – **Maximum Credits – 1**  
      (Research Publication in a Magazine / Transaction / Journal as decided by the honors / minor co-ordinator)

   c. **Seminar - Maximum Credits – 1**  
      (Seminar to be given on a topic consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors / minor co-ordinator. The assessment and evaluation scheme would as per the guidelines used for Technical Seminar at UG level by respective Dept.)

   d. **Honors / Minors Project – Maximum Credits – 2**  
      (Project Topic and Scope, its progress and final assessment consistent with the scope of the Honors or Minor. The topic Selection is to be approved by the honors / minor co-ordinator. The assessment would as per the guidelines and evaluation scheme used for Project Work at UG level by respective Dept.)

   e. **Industrial Training** – **Maximum credits – 4**  
      (An Industrial Training in an Industry identified by the student, approved by the honors / minor co-ordinator & Head of Department. The assessment would as per the guidelines and evaluation scheme used for Industrial Training at UG level by respective Dept.)
Note:

a. 4 Credits would be awarded to the students for a complete 12 Week Industrial Training and meeting with the assessment and evaluation requirements.

b. Provision can be made for the students unable to procure a 12 week Industrial Training. A 4 week or 8 week Industrial Training may also be offered. 2 credits will be awarded for 8 week Industrial Training and 1 Credit would be awarded to the students for a 4 Week Industrial Training, meeting with the assessment and evaluation requirements.

c. No Industrial Training less than 4 weeks be considered for award of 1 Credit.

d. No cumulative addition of Industrial Training period would be considered for award of credits.

The student is expected to earn 1 Credit from Part (A) and remaining 4 Credits from Part (B).