# UNIVERSITY OF MUMBAI

## Bachelor of Engineering

**Instrumentation Engineering (Fourth Year – Sem. VII & VIII), Revised course**
**(REV- 2012) from Academic Year 2015 -16,**
**Under**

# FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

| Subject Code | Subject Name | Teaching Scheme | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract/ Tut. | Theory | Pract/ Tut. | Total |
| ISC701 | Industrial Process Control | 4 | 2 | 4 | 1 | 5 |
| ISC702 | Biomedical Instrumentation | 4 | 2 | 4 | 1 | 5 |
| ISC703 | Advanced Control Systems | 4 | 2 | 4 | 1 | 5 |
| ISC704 | Process Automation | 4 | 2 | 4 | 1 | 5 |
| ISE705X | Elective-I | 4 | 2 | 4 | 1 | 5 |
| ISP706 | Project-I | - | 6 | - | 3 | 3 |
| Total | | 20 | 16 | 20 | 8 | 28 |

| Subject Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISC701 | Industrial Process Control | 20 | 20 | 20 | 80 | 03 | 25 | 25 | 150 |
| ISC702 | Biomedical Instrumentation | 20 | 20 | 20 | 80 | 03 | 25 | 25 | 150 |
| ISC703 | Advanced Control Systems | 20 | 20 | 20 | 80 | 03 | 25 | 25* | 150 |
| ISC704 | Process Automation | 20 | 20 | 20 | 80 | 03 | 25 | 25 | 150 |
| ISE705X | Elective-I | 20 | 20 | 20 | 80 | 03 | 25 | 25 | 150 |
| ISP706 | Project-I | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| Total | | | | 100 | 400 | -- | 150 | 150 | 800 |

*** Includes both Practical and Oral examination**

| Subject Code | Elective - I | Subject Code | Elective II |
|---|---|---|---|
| ISE7051 | Advanced Embedded System | ISE8041 | Nuclear Instrumentation |
| ISE7052 | Image Processing | ISE8042 | Power Plant Instrumentation |
| ISE7053 | Functional Safety | ISE8043 | Optimal Control theory |
| ISE7054 | Process Modeling & Optimization | ISE8044 | Nano Technology |
| ISE7055 | Wireless communication | ISE8045 | Fiber Optic Instrumentation |

## Project Guidelines

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

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

Faculty Load: In semester VII - 1 (one) period of 1 hour per week per project group

In semester VIII - 2 (Two) period of 1 hour each per week per project group

Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

**Note: The project load for students in VII semester is 6hrs and 12 hrs in VIII semester.**

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ISC701 | Industrial Process Control | 4 | 2 | - | 4 | 1 | - | 5 |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(out of 100) | | | | | | | |
| | | Internal Assessment (out of 20) | | | End sem Exam | Term Work | Pract. and oral | Oral | Total |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISC701 | Industrial Process Control | 20 | 20 | 20 | 80 | 25 | - | 25 | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISC701** | **Industrial Process Control** | **5** |
| **Course Objectives** | • To make the students understand all the processes involved in the industries, the various unit operations and be able to apply control schemes to these processes to get the output with desired specifications.<br>• To make the students acquainted with safety and hazards in industry. | |
| **Course Outcomes** | The students will be able to<br>• Get a complete overview of strategies for process control.<br>• Know all the industrial processes and demonstrate their knowledge in designing the control loops for these processes..<br>• Understand the safety related terms such as classification of hazards in the industry and design Hazard free plant. | |

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

| | | |
|---|---|---|
| | **Iron and steel Industry**: Process flow diagram, Sensors and Control schemes. | |
| 5 | **Batch Process Industries:**<br>**Food processing:** Milk pasteurization.<br>**Pharmaceutical industries**- Penicillin-G production, sensors and control schemes | 07 |
| 6 | **Safety in Instrumentation control systems:**<br>Area and material classification as per IEC and NEC standard, techniques used to reduce explosion hazards, intrinsic safety, and installation of intrinsically safe systems. | 04 |

**Theory Examination:**

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

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

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

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

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

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

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

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

**Text Books :**


1. W.L.McCabe and Julian Smith "Unit operation and chemical engineering" Tata McGrawHill- fifth edition.
2. Bela G. Liptak "Instrument engineers handbook- Process control" Chilton book company- 3rd edition.
3. Bela G. Liptak "Instrumentation in the processing industries" Chilton book company-1st edition.


**Reference Books :**


1. M. Chidambaram, "Complete Control of Processes", Narosa Publishing House.
2. Douglas M. Concidine " Process industrial instruments and controls handbook" Mc-GrawHill- 4th edition.
3. George T. Austin "Shreve's chemical process industries" Mc-GrawHill- fifth edition.
4. George Stephenopoulos, "Chemical process control", PHI-1999.
5. David Lindsey, "Power Plant control and instrumentation – control of boilers HRSG", Institution of Engineering and Technology.
6. G.F. Gilman "Boiler Control Systems Engineering", 2005, ISA Publication.
7. A.M.Y.Razak, Industrial gas turbines Performance and operability", CRC Press Woodhead Publishing Limited and CRC Press LLC.

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract | Tut. | Theory | Pract. | Tut. | Total |
| ISC702 | Biomedical Instrumentation | 4 | 2 | - | 4 | 1 | - | **5** |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term Work | Pract. and oral | Oral | Total |
| | | Internal Assessment (out of 20) | | | End sem Exam | | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| ISC702 | Biomedical Instrumentation | 20 | 20 | 20 | 80 | 25 | - | 25 | **150** |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISC702** | **Biomedical Instrumentation** | **5** |
| **Course Objectives** | • To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement and application of these instruments in diagnosis, therapeutic treatment and imaging fields. | |
| **Course Outcomes** | The students will be able to<br>• Identify various Bio-potential and their specifications in terms of amplitude and frequency.<br>• Understand principle and working of various Biomedical Instruments for diagnosis applications.<br>• Decide the applications of therapeutic instruments for treatment purpose.<br>• Understand applications of imaging instruments and the modalities involved in each technique. | |

| **Module** | **Topics** | **Hrs.** |
|---|---|---|
| **1** | **Bio-Potential and Measurement:**<br>Structure of Cell, Origin of Bio-potential, electrical activity of cell their characteristic and specifications. Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes. | **08** |
| **2** | **Physiological Systems and Related Measurement:**<br>Respiratory system- Physiology of respiration and measurements of respiratory related parameters.<br>Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias.<br>Nervous system- Nerve cell, neuronal communication, nerve-muscle physiology, CNS, PNS. Generation of EEG and its measurement. Normal and abnormal EEG, evoked potential and epilepsy.<br>Muscular system- Generation of EMG signal, specification and measurement. | **12** |

| | | |
|---|---|---|
| | Design of ECG amplifier. | |
| **3** | **Cardiovascular Measurement:**<br>Blood Pressure- Direct and Indirect types, Blood Flow- Electromagnetic and Ultrasonic types, Blood Volume- Types of Plethysmography. (Impedance, Capacitive and Photoelectric), Cardiac Output- Flicks method, Dye-dilution and Thermo-dilution type, Heart sound measurement. | **08** |
| **4** | **Life support Instruments:**<br>Pacemaker- Types of Pacemaker, mode of pacing and its application, Defibrillator- AC and DC Defibrillators and their application, Heart Lung machine and its application during surgery, Haemodialysis system and the precautions to be taken during dialysis. | **08** |
| **5** | **Imaging Techniques:**<br>X-Ray- Generation, X-ray tube and its control, X-ray machine and its application, CT Scan- CT Number, Block Diagram, scanning system and application, Ultrasound Imaging- Modes of scanning and their application, MRI- Concepts and image generation, block diagram and its application. | **10** |
| **6** | **Significance of Electrical Safety:**<br>Physiological effects of electrical current, Shock Hazards from electrical equipment and methods of accident prevention. | **02** |

* **One Hospital Visit is recommended for imaging Instruments.**

**List of Experiments:**

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

**Theory Examination:**

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

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

**Term Work:**

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

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

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

**Assessment:**

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

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

**Text Books:**


1. Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1980.
2. John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th edition, 2010.
3. R. S. Khandpur, "Biomedical Instrumentation", TMH, 2004


**Reference Books:**


1. Richard Aston, "Principles of Biomedical Instrumentation and Instruments", PH, 1991.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", PHI/Pearson Education, 4th edition, 2001.
3. John E Hall, Gyton's Medical Physiology, 12th edition, 2011

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ISC703 | Advanced Control System | 4 | 2 | - | 4 | 1 | - | 5 |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(out of 100) | | | | Term Work | Pract. and oral | Oral | Total |
| | | Internal Assessment (out of 20) | | | End sem Exam | | | | |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISC703 | Advanced Control System | 20 | 20 | 20 | 80 | 25 | 25 | - | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISC703** | **Advanced Control system** | 5 |
| **Course Objectives** | • To make students understand the concept of non linear control, Internal Model Control and Optimal Control.<br>• To Study the stability of Non Linear and Linear systems . | |
| **Course Outcomes** | The Students will be able to<br>• Linearize the non linear physical systems.<br>• Study the non linear system behavior by phase plane and describing function methods<br>• Study the stability of linear and nonlinear systems by Lyapunov method.<br>• Design IMC with Uncertainty and Disturbances. | |

| **Module** | **Content** | **Hours** |
|---|---|---|
| Prerequisite | Modeling of linear systems, Simulation of system, System stability through transient response and frequency response techniques. Superposition theorem for differentiating linear and nonlinear systems. | |
| 1 | **Introduction**<br>Norms for Signals and Systems, Input-Output relationships,<br>**Nonlinear Control Systems**<br>Definition of nonlinear systems, Difference between linear and nonlinear systems, characteristics of nonlinear systems, Common physical nonlinearities<br>**Linearization Methods**<br>Jacobian Linearization, Concept of relative degree, Feedback linearization for systems with no internal dynamics. | 8 |

| | | |
|---|---|---|
| 2. | **Phase-plane Analysis**<br>Phase-plane Analysis, Basic concepts, phase-trajectories, phase portrait, Constructing phase portraits-Analytical Methods, Graphical Method - Delta Method, Determining Time from Phase Portraits, Singular points and their classification, limit cycles and behavior of limit cycles. | 10 |
| 3. | **Describing Function Analysis**<br>Describing Function Fundamentals, Describing Functions of saturation, dead zone, relay and their combinations, Stability analysis of nonlinear systems via describing function method . | 8 |
| 4. | **Lyapunov Stability Analysis**<br>Stability of equilibria, Asymptotic stability graphically , Lyapunov stability theorems, Stability analysis of linear systems, Construction of Lyapunov functions using Krasovskii method and variable gradient method. | 10 |
| 5. | **Internal Model Control**<br>Introduction to Model-Based Control, Open loop controller Design, Model Uncertainty and Disturbances, Development of IMC structure, IMC-Based PID Controller Design | 8 |
| 6 | **Optimal Control**<br>Problem Formulation, Continuous linear regulator problem (LQR),Solution via Control Algebraic Riccati Equation (CARE**)** | 4 |

**List of Laboratory Experiments**

- Nonlinear Control System and Analysis

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

- Lyapunov Stability Analysis

a) Verify Sylvester theorem for the definiteness of the Lyapunov Function.
b) Determine the stability of the system and construct the Lyapunov function for Linear Time Invariant system.
c) By using Krasovskii method determine the stability of the system and construct the Lyapunov function.
d) By using Variable Gradient method determine the stability of the nonlinear system.

- Internal Model Control

a) Effect of filter tuning parameter on step response of the first and second order systems.
b) Design of IMC controller for a system subject to step input.
c) Design of IMC controller for a system subject to ramp input.
d) Design of IMC based PID controller.
e) Design of IMC controller for delay and non-minimum phase systems.

- Optimal Control

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

**Theory Examination**:

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

**Term work:**

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

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

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

**Assessment:**

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

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

**Text Books:**


1. K. Ogata, *Modern Control Engineering,* Prentice Hall of India, 4th edition, 2002.
2. I. J. Nagrath and M. Gopal, *Control System Engineering*, 3rd Edition, New Age International (P) Ltd., Publishers - 2000.


**Reference Books:**


1. Slotine, Li - “Applied Nonlinear Control”
2. M. Gopal, "Modern Control System Theory", Wiley Eastern Ltd., New Delhi.
3. John Doyle, Bruce Francis, Allen Tannenbaum, “Feedback Control Theory”.
4. Pierre R. Belanger, “Control Engineering” Saunders college Publishing.
5. Donald E. Kirk, “Optimal Control Theory- An Introduction,”.

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ISC704 | Process Automation | 4 | 2 | - | 4 | 1 | - | 5 |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(out of 100) | | | | Term Work | Pract. and oral | Oral | Total |
| | | Internal Assessment (out of 20) | | | End sem Exam | | | | |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISC704 | Process Automation | 20 | 20 | 20 | 80 | 25 | - | 25 | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISC704** | **Process Automation** | **5** |
| **Course Objectives** | • To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA. Students should understand the working of these systems and should be able to determine hardware and software requirements of PLC, DCS and SCADA. They should further understand how to design any application based on these systems. Also they should understand the requirements of safety and design safety instrumented systems. | |
| **Course Outcomes** | The students will be able to<br>• Define automation, it's importance, expectations from automation and applications in industry.<br>• Understand working of PLC, I/O modules of PLC, Programming languages and instructions of PLC, design PLC based application by proper selection and sizing criteria, developing GUI and ladder program.<br>• Understand evolution and architecture of DCS, hierarchical control in DCS, programming DCS through function Block Diagram (FBD) method.<br>• SCADA architecture, communication in SCADA, develop any application based on SCADA along with GUI using SCADA software.<br>• Understand the need of SIS, risk reduction methods, evaluation of SIL( Safety Integrity Levels) | |

| **Module** | **Topics** | **Hrs.** |
|---|---|---|
| 1 | **Automation Fundamentals**<br>Automation and its importance, automation applications, expectations of automation. Process and factory automation.<br>Types of plant and control – categories in industry, open loop and close loop | 04 |

| | | |
|---|---|---|
| | control functions, continuous processes, discrete processes, and mixed processes.<br>Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control.<br>Control system architecture – evolution and current trends, comparison of different architectures. | |
| 2 | **Programmable Logic Controller**<br>**Hardware**<br>Evolution of PLC, Definition, functions of PLC, Advantages, Architecture, working of PLC, Scan time, Types & Specifications.<br>DI-DO-AI-AO examples and ratings, I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules,<br>Memory & addressing- memory organization (system memory and application memory), I/O addressing, hardware to software interface.<br>**Software**<br>Development of Relay Logic Ladder Diagram, introduction to PLC Programming, programming devices, IEC standard PLC programming languages, LD programming- basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC.<br>**Case study:**<br>PLC selection and configuration for any one process applications**.** | 14 |
| 3 | **Distributed Control System** (**DCS**)<br>Introduction to DCS. Evolution of DCS, DCS flow sheet symbols, architecture of DCS. Controller, Input and output modules, Communication module, data highway, local I/O bus, Workstations, Specifications of DCS.<br>Introduction of Hierarchical control of memory: Task listing, Higher and Lower computer level task.<br>Supervisory computer tasks DCS configuration. Supervisory computer functions, Control techniques, Supervisory Control Algorithm. DCS & Supervisory computer displays, advanced control Strategies, computer interface with DCS.<br>DCS. System integration with PLCs computer: HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks.<br>Introduction to DCS Programming, Function Block Diagram method for DCS programming. | 12 |
| 4 | **Supervisory Control and Data Acquisition (SCADA)**<br>SCADA introduction, brief history of SCADA, elements of SCADA.<br>Features of SCADA , MTU- functions of MTU, RTU- Functions of RTU, Protocol Detail<br>SCADA as a real time system Communications in SCADA- types & | 10 |

| | | |
|---|---|---|
| | methods used, components, Protocol structure and Mediums used for communications<br>SCADA Development for any one typical application<br>Programming for GUI development using SCADA software. | |
| 5 | **Database and Alarm Management, MES, ERP**<br>Database management,<br>Philosophies of Alarm Management, Alarm reporting, types of alarms generated and acceptance of alarms.<br>MES, Integration with enterprise system. | 04 |
| 6 | **Safety Instrumented System (SIS)**<br>Need for safety instrumentation- risk and risk reduction methods, hazards analysis. Process control systems and SIS.<br>Safety Integrity Levels (SIL) and availability. Introduction to the international functional safety standard IEC61508 | 04 |

**List of Experiments:**

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

**Theory Examination:**

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

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

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

| | |
|---|---|
| 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:**

1 Samuel M. Herb , " Understanding Distributed Processor Systems for Control", ISA Publication.

2. Thomas Hughes, "Programmable Logic Controller", ISA Publication.

3. Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication.

4. Gruhn and Cheddie, "Safety Shutdown Systems" – ISA, 1998,

**Reference Books:**

1. Poppovik Bhatkar, "Distributed Computer Control for Industrial Automation", Dekkar Publication.
2. S.K.Singh, "Computer Aided Process Control", Prentice Hall of India.
3. Krishna Kant, "Computer Based Process Control", Prentice Hall of India
4. N.E. Battikha, "The Management of Control System: Justification and Technical Auditing", ISA.
5. Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001.
6. John. W.Webb, Ronald A Reis, "Programmable Logic Controllers – Principles and Applications", 3rd edition, Prentice Hall Inc., New Jersey, 1995.
7. Bela G. Liptak "Instrument engineers handbook- Process control" Chilton book company- 3rd edition.
8. D.J. Smith & K.G.L. Simpson, "Functional Safety: A Straightforward Guide to IEC61508 and Related Standards", -Butterworth-Heinemann Publications.

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ISE7051 | Advanced Embedded Systems | 4 | 2 | - | 4 | 1 | - | 5 |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(out of 100) | | | | | | | |
| | | Internal Assessment (out of 20) | | | End sem Exam | Term Work | Pract. and oral | Oral | Total |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISE7051 | Advanced Embedded Systems | 20 | 20 | 20 | 80 | 25 | - | 25 | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISE7051** | **Advanced Embedded systems** | **5** |
| **Course Objectives** | • To make students understand the 32bit processors and higher architectures and configuration.<br>• Use of Real Time systems and there design in Instrumentation systems. | |
| **Course Outcomes** | The students will be able to<br>• Designing using ARM processors<br>• Use Real time software for designing instrumentation systems<br>• Design with configurable hardware systems | |

| **Module** | **Topics** | **Hrs.** |
|---|---|---|
| 1 | **ARM Processor**<br>Introduction to ARM7 & ARM9 Architecture<br>ARM 7: ARM-THUMB mode, programming model, instruction set, and programming. | 06 |
| 2 | **LPC2148 architecture**<br>Development tools for High level language-C,Device programming & ISP.<br>On-Chip Device peripherals<br>RTC programming<br>On-chip ADC programming for Signal Sampling<br>Watchdog timer | 15 |

| | | |
|---|---|---|
| | Timer programming- Timer / Capture mode<br>Serial port programming for PC communication<br>PWM Signal generation<br>Idle and Power down mode<br>Interrupt handling<br>Universal serial Bus<br>Interfacing peripherals | |
| 3 | **System Design**<br>**I**nstrumentation System design with ARM processor<br>(Instrumentation Hardware design to be at Block level only)<br>Eg: Data acquisition systems<br>PID Heater controller etc | 06 |
| 4 | **FreeRTOS**<br>FreeRTOS design,Task & Scheduler API's,Queue API,Semaphore API<br>Software Timer API | 08 |
| 5 | **Designing with FreeRTOS**<br>LPC2148 port and design using FreeRTOS | 08 |
| 6 | **Configurable Hardware**<br>Introduction and Architecture of PAL, PLA, CPLD, FPGA. Comparison of above devices & application areas. Advantages of above. Introduction to development tools. Project development cycle. Introduction of Hardware description Languages and its Features.<br>Introduction to ASIC, PSOC. | 05 |

**List of Experiments:**

2 application case studies, & Experiments mentioned in the Unit 2 & 4 above (Use of RTOS is recommended wherever applicable).
A seminar presented by a group of about three students on latest state-of-the-art technologies in Embedded systems: Processor families and trends, Embedded Devices like Digital Camera, Cruise Controller, Mobile phone, Smartcard based Applications & Systems, Point of Sale terminals, DVD Systems, CPLD, FPGA, VHDL, Verilog etc., Various RTOSs like VxWorks, RTLinux, pSOS, Handheld OS- Symbian etc., Selection criteria & development tools For various processors like Cortex-M3, ARM9.

**Theory Examination:**

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

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

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

| | |
|---|---|
| Laboratory work (Experiments) | : 10 Marks |
| Laboratory work (programs / journal) | : 10 Marks |
| Attendance (Theory and Practical) | : 5 Marks |

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

**Assessment:**

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

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

**Reference Books:**


1. Rajkamal, Embedded Systems Architecture Programming and Design, McGraw Hill, Second Edition.
2. Dr.K.V.K.K.Prasad, Embedded /Real Time Systems: Concept, Design and Programming, DreamTech Press.
3. John F. Wakerly, Digital Design Principles and Practices 4th Edition, Pearson Prentice Hall.
4. Embedded Systems: An Integrated Approach by Lyla B.Das
5. FreeRTOS manual
6. LPC2148 Datasheet

| Sub Code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical/ oral | Tutorial | Total |
| ISE7052 | Image Processing | 4 | 2 | - | 4 | 1 | - | 5 |

| Sub Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(Out of 100) | | | | Term Work | Prac and Oral | Oral | Total |
| | | Internal Assessment (out of 20) | | | End Sem Exam | | | | |
| | | Test-I | Test-I | Avg | | | | | |
| ISE7052 | Image Processing | 20 | 20 | 20 | 80 | 25 | - | 25 | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| ISE7052 | Image Processing | 5 |
| **Course Objectives** | • The principle of the syllabus is to give an introduction to basic concepts and methodologies for digital image processing .The students are expected to develope a foundation that can be used as the basis for further study and research in this field.<br>• The syllabus gives great emphasis on basic principles as well as more advanced techinques for image enhancement,segementation, morophological operations etc | |
| **Course Outcomes** | • Student will be able to understand the basic concepts and methodologies for digital image processing.<br>• Students will be able to study and program advanced techniques for image enchancement ,segementation morophological operations etc. | |

| **Module** | **Contents** | **Hours** |
|---|---|---|
| 1 | **Introduction:** Definition of image, generation of image, steps in image processing, elements of digital image processing systems, image enhancements, restoration and analysis.<br>**Digital Image Fundamentals:** Elements of visible perception, image model, sampling and quantization, relationships between pixels, imaging geometry. | 8 |

| | | |
|---|---|---|
| 2 | **Image Transforms:** Introduction to D.F.T., 2-D.F.T., F.F.T., other seperable image transforms (walsh, hadamard, discrete cosine, haar, slant, KL) | 8 |
| 3 | **Image Enhancements:** Point operations, histogram modeling, spatial filtering-smoothing, sharpening, low pass, high pass, homomorphic filtering.<br><br>**Image Restoration:** Image observation models, inverse and wiener filtering, F.I.R. wiener filters, filtering using image transforms, least squares filters, generalized inverse, S.V.D. and interactive methods, recursive filtering, causal models, digital processing of speckle images, maximum entropy restoration. | 17 |
| 4 | **Image Segmentation:** Detection of discontinuities, age linking and boundary detection, thresholding, region oriented segmentation, use of motion in segmentation. | 5 |
| 5 | **Image Data Compression**: Introduction, pixel coding, predictive techniques (PCM, DPCM, etc), transform coding theory of images, hybrid coding and vector DPCM. | 5 |
| 6 | **Morphological Image Processing:** Preliminaries,erosion and dilation,opening and closing,the Hit-or-Miss transformation,some morphological algorithms Like thinning,thickening,skeletons | 5 |

**LIST OF EXPERIMENTS:**

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

**Theory Examination:**

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4

to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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

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

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

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

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

**Text Books:**

1. R. C. Gonzalez, “Image Processing” Pearson Education 2nd edition, 1999.
2. A. K. Jain, “Fundamental of Digital Image Processing”, PHI 2nd edition, 1995.
3. W. K. Pratt, “Digital Image Processing”, John Wiley and Sons, 1994.


**Reference Books:**


1. C. Phillips, “Image Processing in C”, BPB Publication, 1995.
2. B. Chanda, D. Dutta Majumdar, “Digital Image processing”, PHI, 2000.
3. Emmauel C. Ifeachor and Barry W. Jervis, “Digital Signal Processing”, Pearson Education, 2nd edition, 2000.
4. Don Pearson, “Image Processing” (The ESSEX series in Telecommunication and information systems, McGraw Hill International ELTL engg. Series), 1991.
5. Johnny Johnson, “Introduction to DSP”, PHI - 1996.
6. Proakis, “DSP”, PHI 1997.
7. Rabnier Gold, “Theory and Application of DSP”, PHI, 1996.
8. Milan Sonka, Vaclav Hlavac, “Image Processing analysis and machine vision”,Thomson Learning, 2nd edition, 1999

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract | Tut. | Total |
| ISE7053 | Functional Safety | 4 | - | 2 | 4 | --- | 1 | 5 |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(out of 100) | | | | | | | |
| | | Internal Assessment (out of 20) | | | End sem Exam | Term Work | Pract. and oral | Oral | Total |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISE7053 | Functional safety | 20 | 20 | 20 | 80 | 25 | - | 25 | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISE7053** | **Functional Safety** | **5** |
| **Course Objectives** | To make the students aware of basic concepts of safety instrumented system, standards and risk analysis techniques. | |
| **Course Outcomes** | The students will be able to<br>• Understand the role of Safety instrumented system in the industry.<br>• Identify and analyse the hazards,<br>• Select the Safety integrity level. | |

| **Module** | **Topics** | **Hrs.** |
|---|---|---|
| 1 | **Introduction :**<br>Safety Instrumented System (SIS) - need, features, components, difference between basic process control system and SIS, Risk: how to measure risk, risk tolerance, Safety integrety level,safety instrumented functions.<br>Standards and Regulation – HSE-PES, AIChE-CCPS, IEC-61508, ANSI/ISA-84.00.01-2004 (IEC 61511 Mod ) & ANSI/ISA – 84.01-1996.9, NFPA 85.10, API RP 556,11 , API RP 14C,11, OSHA (29 CFR 1910.119 – Process Saftey Management of Highly Hazardous Chemicals), | 06 |
| 2 | **Safety life cycle:**<br>Standards and safety life cycle, analysis phase, realisation phase, operations phase Allocation of Safety Functions to Protection Layers, Develop Safety Requirements Specifications, SIS Design and Engineering, Installation, Commissioning and Validation, Operations and Maintenance, Modification, De-commissioning. | 06 |
| 3 | Process Control – Active / Dynamic , Safety Control – Passive / Dormant, Demand Mode vs. Continuous Mode, Separation of Control and Safety Systems - HSE-PES, AIChE-CCPS, IEC-61508, Common Cause and Systematic or Functional Failures,<br>Protection Layers : prevention and mitigation layers, SIS Technologies: Pneumatic Systems, Relay Systems, Solid State Systems, Microprocessors / | 08 |

| | | |
|---|---|---|
| | PLC (Software based) Systems | |
| 4 | **Rules of Probability:**<br>Assigning probability to an event, types of events and event combination, combining event probabilities, fault tree analysis, failure rate and probabiuity, simplifications and approximations. | 08 |
| 5 | **Process Hazard Analysis:**<br>Consequence analysis: Characterisation of potential events, dispersion, impacts, occupancy considerations, consequence analysis tools.<br>Likelihood analysis: estimation and statistical analysis, fault propagation, event tree analysis and fault tree analysis, Quantitative layer of protection analysis: multiple initiating events, estimating initiating event frequencies and IPL failure probabilities | 12 |
| 6 | **Determining the Safety Integrity Level ( SIL ) :**<br>Evaluating Risk, Safety Integrity Levels, SIL Determination Method : As Low As Reasonably Practical ( ALARP ), Risk matrix, Risk Graph, Layers Of Protection Analysis ( LOPA ) | 08 |

**Theory Examination:**

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

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

**Term Work:**
Term work shall consist of minimum six assignments and two assignments with EXCEL.
The distribution of marks for term work shall be as follows:

| | |
|---|---|
| Laboratory work | : 10 Marks |
| Laboratory work (programs / journal) | : 10 Marks |
| Attendance | : 05 Marks |

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

**Assessment:**

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

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

**Reference Books:**


1. Paul Gruhn and H Jarry L. Cheddie," Safety Instrumented systems: Design, Analysis and Justification", ISA , 2nd edition, 2006
2. Dr. Eric W Scharpf, Heidi J Hartmann, Harlod W Thomas, " Practical SIL target selection : Risk analysis per the IEC 61511 safety Lifecycle", exida,2012.
3. Ed Marszal, Eric W Scharpf , "Safety Integrity Level Selection", ISA.

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract | Tut. | Total |
| ISE7054 | Process Modeling & Optimization | 4 | - | 2 | 4 | --- | 1 | 5 |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(out of 100) | | | | Term Work | Pract. and oral | Oral | Total |
| | | Internal Assessment (out of 20) | | | End sem Exam | | | | |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISE7054 | Process Modeling & Optimization | 20 | 20 | 20 | 80 | 25 | - | 25 | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISE7054** | **Process Modeling & Optimization** | 05 |
| **Course Objectives** | • To make students understand the basic approach to the problem of mathematical modeling and identifying the variables by using direct methods.<br>• To translate a descriptive statement of the design problem into a mathematical statement for optimization.<br>• To use numerical methods for solving engineering optimization problems. | |
| **Course Outcomes** | Students will be able to<br>• formulate mathematical models of the complex engineering systems.<br>• to use an optimization algorithm to solve linear and nonlinear optimization problems.<br>• explain the kind of interaction possible with an optimization algorithm. | |

| **Module No.** | **Contents** | **Hours** |
|---|---|---|
| 1. | **Mathematical Modeling**<br>Definition of Mathematical model, Classifications of Models, How to build a model, Use of mathematical models and principles of formulation, Fundamental laws: Continuity equations, Energy equation, Equations of motion, Chemical kinetics, Modeling of CSTR (isothermal, no-isothermal, constant holdup, variable holdup). | 07 |

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

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

**Theory Examination**:

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

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

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

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

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

**Assessment:**

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

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

**Text Books:**


1. S. S. Rao, "Optimization", 2nd edition, New Age International (P) Ltd., Publishers, New Delhi, 1995.
2. Jasbir S. Arora, "Introduction to Optimum Design", ELSEVIER, Academic Press, USA – 2004.
3. T. E. Edger and D. M. Himmeblaue, "Optimization of Chemical Processes", McGraw Hill International Editions, 1989.
4. William L. Luyben, "Process Modeling, Simulation, And Control For Chemical Engineers" McGraw-Hill Publishing Company,1990.


**Reference Books:**


1. Kalyanmoy Deb, "Optimization For Engineering Design", Prentice Hall of India (P) Ltd., New Delhi, 1998.
2. Ashok D. Belegundu, "Optimization concepts and applications in Engineering", Pearson Education, 2002.
3. Hamby A. Taha, "Operation Research", Pearson education - 2007.

| Sub code | Subject Name | Teaching Scheme (Hrs) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ISE7055 | Wireless Communication | 4 | 2 | - | 4 | 1 | - | 5 |

| Sub code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory(out of 100) | | | | Term Work | Pract. and oral | Oral | Total |
| | | Internal Assessment (out of 20) | | | End sem Exam | | | | |
| | | Test 1 | Test 2 | Avg. | | | | | |
| ISE7055 | Wireless Communication | 20 | 20 | 20 | 80 | 25 | - | 25 | 150 |

| **Subject Code** | **Subject Name** | **Credits** |
|---|---|---|
| **ISE7055** | **Wireless Communication** | **5** |
| **Course Objectives** | • To make students understand concept of Wireless Communication in real time process control application. | |
| **Course Outcomes** | The students will be able to<br>• Basics of Wireless Communication Systems<br>• Understands Wireless Transceivers and Advanced Transceivers<br>• Understands Wireless Application Protocol<br>• Understands Different Wireless trends in Industry | |

| **Module** | **Topics** | **Hrs.** |
|---|---|---|
| 1 | **Introduction to Wireless Communication:-**<br>History, Types of services: Broadcast, paging, cellular Telephony, cordless telephony, Wireless LAN (WLAN), Ad Hoc Network, Personal Area Network (PAN), Wireless Sensors networks<br>Bandwith concept, Technical challenges of Wireless Communication: Multipath propagation, spectrum limitations<br>Present scenario in Wireless Communication Systems | 10 |
| 2 | **Wireless Transceivers:**<br>Quadrature Phase shift keying, differential quadrature phase shift keying, offset quadrature phase shift keying, minimum phase shift keying, Gaussian minimum shift keying, power spectrum and error performance in fading channels. | 08 |
| 3 | **Advanced Transceivers:**<br>Spread spectrum systems TDMA, SDMA, CDMA, FDMA principle, power control, effects of multipath propagation on CDMA, OFDM, DSSS and FHSS. | 06 |

| | | |
|---|---|---|
| 4 | **Wireless Application Protocol (WAP):**<br>Introduction, WAP and the World Wide Web (WWW), Introduction to Wireless Application Protocol, The WAP Programming Model, WAP Architecture, WAP Advantage and Disadvantages, Application of WAP, imode, imode versus WAP | 08 |
| 5 | **Application of Wireless Communication:**<br>Bluetooth, Ultra Wide Band, Zigbee, WiFi, Introduction to 3G & 4G | 06 |
| 6 | **WirelessHART:**<br>WirelessIntroduction<br>*Wireless*HART Security Overview<br>*Wireless*HART Adaptor<br>*Wireless*HART Gateway<br>Co-Existence of *Wireless*HART with other Wireless Technologies<br>Control with *Wireless*HART<br>System redundancy with *Wireless*HART<br>Peer-to-Peer Communication with *Wireless*HART<br><br>**Introduction to Wireless Foundation Fieldbus** | 10 |

**Theory Examination:**

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

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

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

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

**Assessment:**

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

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. Theodore S. Rappaport, "Wireless Communications Principles and Practice", PEARSON, 4th impression, 2011
2. Andreas F. Molisch, "Wireless Communications", WILEY-INDIA, 2006
3. Vijay K. Garg, "Wireless Communications and Networking", Morgan Kaufmann Publishers,2009
4. http://www.hartcomm.org


**Reference Books:**


1. Andrea Goldsmith, "Wireless Communications", CAMBRIDGE UNIVERSITY PRESS, 2005
2. Davis Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", CAMBRIDGE UNIVERSITY PRESS, 1st ed., 2005
3. Xiaodong Wang, H. Vincent Poor, "Wireless Communication Systems", PEARSON, 1st ed., 2004
4. Upena Dalal, "Wireless Communication", OXFORD UNIVERSITY PRESS, 2nd impression, 2010
5. NIIT, "Basics of Wireless Communications", Prentice-Hall of India,2004
6. William Stallings, "Wireless Communications and Networks", PEARSON, 5th ed., 2004
7. T.L. Singal, Wireless Communications, Tata McGraw Hill ,2010