AC
Item No.

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2019 'C' Scheme) from AcademicYear 2019 -20

Under

FACULTY OF SCIENCE &TECHNOLOGY

Instrumentation Engineering

Second Year with Effect from **AY 2020-21**
Third Year with Effect from **AY 2021-22**
Final Year with Effect from **AY 2022-23**

(As the per AICTE guidelines with effect from the academic year 2019–2020)

Preamble

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

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. Italsofocusesoncontinuousevaluationwhichwillenhancethequalityofeducation. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum skill-based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C’ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Member, Academic Council, RRC in Engineering
University of Mumbai

From Chairman's Desk

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

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

Program Educational Objectives (PEOs)

- *Graduates will have successful career in industry or pursue higher studies to meet future challenges of technological development.*
- *Graduates will develop analytical and logical skills that enable them to analyze and design Instrumentation and Control Systems.*
- *Graduates will achieve professional skills to expose themselves by giving an opportunity as an individual as well as team.*
- *Graduates will undertake research activities in emerging multidisciplinary fields.*

Program Outcomes (POs)

- **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern

engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. Alice N. Cheeran
Chairman,
Board of Studies in Instrumentation Engineering,
Member - Academic Council, University of Mumbai
Dr. Mukesh D.Patil-Member BoS
Dr.Sharad P.Jadhav-Member BoS
Dr. Dipak D Gawali-Member BoS
Dr.M. J Lengare-Member BoS
Dr.Harish K. Pillai-Member BoS

Program Structure for Final Year B.E Instrumentation Engineering
(With Effect from 2022-2023) Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ISC701	Instrumentation Project Documentation & Execution	3	--	3	--	3
ISC702	Process Automation	3	--	3		3
ISDOC701X	Department Optional Course– 3	3	--	3	--	3
ISIOC701X	Institute Optional Course–1	3	--	3	--	3
ISL701	Instrumentation Project Documentation & Execution - Lab	--	2	--	1	1
ISL702	Process Automation -Lab	--	2	--	1	1
ISL703X	Department Optional Course-3 -Lab	--	2	--	1	1
ISP701	Major Project-I	--	6#	--	3	3
Total		**12**	**12**	**12**	**6**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	PR/ OR	Total
		Internal Assessment			End Sem Exam	Exam. Duration (inHrs)			
		Test 1	Test 2	Avg					
ISC701	Instrumentation Project Documentation & Execution	20	20	20	80	3	--	--	100
ISC702	Process Automation	20	20	20	80	3	--	--	100
ISDOC701X	Department Optional Course– 3	20	20	20	80	3	--	--	100
ISIOC701X	Institute Optional Course–1	20	20	20	80	3	--	--	100
ISL701	Instrumentation Project Documentation & Execution - Lab	--	--	--	--	--	25	25	50
ISL702	Process Automation–Lab	--	--	--	--	--	25	25	50
ISL703X	Department Optional Course -3 – Lab	--	--	--	--	--	25	25	50
ISP701	Major Project-I	--	--	--	--	--	50	50	100
Total		--	--	**80**	**320**	--	**125**	**125**	**650**

# Indicates the workload of Learner (Not Faculty), for Major Project

Program Structure for Final Year B.E Instrumentation Engineering
(With Effect from 2022-2023)
Scheme for Semester -VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ISC801	Instrument and System Design	3	--	3	--	3
ISDOC801X	DepartmentOptionalCourse– 4	3	--	3	--	3
ISDOC802X	DepartmentOptionalCourse– 5	3	--	3	--	3
ISIOC801X	InstituteOptionalCourse–2	3	--	3	--	3
ISL801	Instrument and System Design– Lab	--	2	--	1	1
ISL802X	DepartmentOptionalCourse -4 -Lab	--	2	--	1	1
ISP801	MajorProject-II	--	12#	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ISC801	Instrument and System Design	20	20	20	80	3	--	--	100
ISDOC801X	Department Optional Course– 4	20	20	20	80	3	--	--	100
ISDOC802X	Department Optional Course– 5	20	20	20	80	3	--	--	100
ISIOC801X	Institute Optional Course–2	20	20	20	80	3	--	--	100
ISL801	Instrument and System Design –Lab	--	--	--	--	--	25	25	50
ISL802X	Department Optional Course -4 -Lab	--	--	--	--	--	25	25	50
ISP801	Major Project-II	--	--	--	--	--	50	100	150
Total		**--**	**--**	**80**	**320**	**--**	**100**	**150**	**650**

# Indicates the workload of Learner (Not Faculty), for Major Project

Students group and a load of faculty per week.

Mini Project 1 and2:
Students can form groups with a minimum of 2(Two) and not more than 4(Four)
FacultyLoad:1 hour per week per four groups

Major Project 1 and2:
Students can form groups with minimum 2 (Two) and not more than 4(Four)
Faculty Load : In SemesterVII– ½ hour per week per project group
In Semester VIII – 1-hour per week per project group

Department Optional Course – 1 (Semester- V)

ISDOC5011	Analytical Instrumentation	**No Lab work**
ISDOC5012	Data Structures and Algorithms	
ISDOC5013	Mechatronics	
ISDOC5014	Advanced Sensors	

Department Optional Course – 2 (Semester-VI)

ISDOC 6011	Instrumentation for Agriculture	**No Lab work**
ISDOC 6012	Optimization Techniques	
ISDOC 6013	Database Management Systems	
ISDOC 6013	Biosensors and Signal Processing	

Department Optional Course – 3 (Semester- VII)

ISDOC 7011	Biomedical Instrumentation	**Lab work**
ISDOC 7012	Machine Learning	
ISDOC 7013	Advanced Control System	
ISDOC 7014	Advanced Microcontroller	

Department Optional Course – 4 (Semester- VIII)

ISDOC 8011	Digital Control System	**Lab work**
ISDOC 8012	Expert System	
ISDOC 8013	Digital Image Processing	
ISDOC 8014	Internet of Things	
ISDOC 8015	Advanced Biomedical Instrumentation	

Department Optional Course – 5 (Semester-VIII)

ISDOC 8021	Advanced Digital Signal Processing	**No Lab work**
ISDOC 8022	Building Automation	
ISDOC 8023	Functional Safety	
ISDOC 8024	Power Plant Instrumentation	
ISDOC 8025	Optimal Control System	

Note: As per above Examination Scheme, the Minimum marks for passing are as follows –

Max. Marks	Min. marks
80	32
50	20
25	10
20	8

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC701	Instrumentation Project Documentation and Execution	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC701	Instrumentation Project Documentation and Execution	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
	Instrumentation Project Documentation and Execution	3
Course Objectives	1. To provide knowledge of Instrumentation Project & Detailed Engineering techniques in the EPC Consultancy. 2. To make the students capable of executing Project Deliverables and Engineering activities of Project Documentation.	
Course Outcomes	The students will be able to: 1. Interpret types of projects and execute it by knowing the relationship between customer, desi,gner and constructor. 2. Apply standards in instrumentation projects and prepare basic engineering documents. 3. Design engineering documents such as loop diagram, hook-up, JB schedule. 4. Develop and test system integration. 5. Schedule and evaluate activities like procurement, commissioning, and installation. 6. Support and evaluate documentation software packages used in industry.	

Module	Contents	Hrs.	CO Mapping
1	**The Project and Project Team:** Introduction, Types of projects, structure, Project scope, Project flow and deliverables, Need and techniques used for Project Planning and Scheduling **The Project Team:** Customer, designer and constructor; Responsibility matrix.	05	CO1
2	**Project Documentation Standards**: Introduction to ISA (ISA 5.1, 5.2, 5.4, ISA 20 etc), NEMA, ANSI standards. **Project Engineering Documents:** Preliminary Engineering Documents: PFD, P&ID (ISA S-5.1), Cause and effect diagram. Front End Engineering and Design (FEED) documents: Instrument index sheet, I/O schedule, Instrument specification sheets (ISA S-20) for pressure, temperature, flow and level instruments.	10	CO2
3	**Detailed Engineering Design:** Instrument Loop wiring diagrams (ISA S-5.4), (ISA S-5.2), Instrument Hook up, BOM, Instrument Location Plan **Cable Engineering:** Class of conductors, Types, Specification, Selection, Cable schemes, Cable trays. Earthing and Grounding for General and power Signals. Power Distribution diagram, Earthing Diagram, Cable and Junction box schedule	07	CO3
4	**Construction activities:** Site conditions and planning, Installation activities/ procedures and documents required. Types of operating Stations, Control system specifications, Control system graphics (ISA S5.5), databases, I/O allocation and configuration. **System Integration:** HMI specification Development, System Architecture Design: Network single line diagram generation.	07	CO4
5	**Procurement activities**: Pre-Qualification Evaluation of Vendor, Vendor registration, Tendering and bidding process and required documents, Bid evaluation, Purchase orders. **Commissioning and Testing Activities:** Panel testing Procedure and its documentation. Factory Acceptance Test (FAT), Customer Acceptance Test (CAT), Site inspection and testing (SAT), Calibration records, Test and inspection reports. Cold Commissioning and hot commissioning, punch list.	06	CO5
6	**Overview of project documentation tools:** Introduction of various tools for project engineering documentation and project planning /scheduling.	04	CO6

Internal 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.

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.

Text Books:

1. Andrew &Williams ,*"Applied instrumentation in process industries",* Gulf Publishing.
2. Peter Watermeyer*, "Hand book for Process Plant Project Engineers",* Professional Engineering Publishing, 2002.
3. John Bacon, *"Management systems"*, (ISA)
4. B.G. Liptak, *"Hand book-Process control Instrument Engineers"* .
5. Michael D. Whitt ,*"Successful Instrumentation & Control Systems Design*", ISA
6. Pradeep Pai , *"Project Management"*, Pearson Education.
7. B.C. Punmia and K.K. Khandelwal, *"Project Planning and Control with PERT and CPM",* Laxmi Publications Private Limited.

Reference Books:

1. Harold Kerzner, Van Nostrand, *"Project Management A System Approach to Planning, Scheduling and Controlling",* Reinhold Publishing, 2001.
2. ISA Manual,*"Instrument Installation and Project Management*",2000.
3. ANSI-ISA,*"Instrumentation Symbols and Identification*", 1992.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC702	Process Automation	3	-	-	3		-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 80)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC702	Process Automation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC702	Process Automation	3
Course objective	• To give the students fundamentals of automation and various automation systems used in industry such as PLC, SCADA, and DCS. • To impart the knowledge about the architecture, working of PLC, SCADA and DCS • To make the students capable to apply knowledge to identify hardware and software requirements of PLC, SCADA and DCS • To give the students a comprehension of the aspects related to Safety Instrumented system (SIS).	
Course Outcome	The students will be able to- 1. Define automation, it's need, importance and applications in industry. 2. Identify components of PLC and develop PLC ladder and design PLC based application by proper selection and sizing criteria. 3. Describe SCADA architecture, communication in SCADA and develop any application based on SCADA along with GUI using SCADA software. 4. Explain evolution and architecture of DCS, hierarchical control in DCS, programming DCS through Function Block Diagram (FBD) method. 5. Describe database and alarm management system 6. Identify the components of SIS, risk reduction methods, evaluation of SIL (Safety Integrity Levels)	

Details of Syllabus:

Prerequisite: Knowledge of Digital Electronics, Process Instrumentation and Control.

Module	Content	Hrs.	CO Mapping
1	**Automation Fundamentals** Automation, Need for automation and its importance, Types of automation, Process and factory automation.Automation applications, Industry 4.0 automation systems architecture. Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control.	04	**CO1**
2	**Programmable Logic Controller** **Hardware** Evolution of PLC, PLC Architecture,Types & Specifications. Safety PLC I/O modules, local and remote I/Oexpansion, special purpose modules, wiring diagrams of different I/Omodules, communication modules, Memory & addressing- memory organization,I/O addressing, hardware to software interface. **Software** introduction to PLCProgramming, programming devices, IEC standard PLC programminglanguages, LD programming- basic LD instructions, PLC Timers andCounters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC. **Case study:** PLC selection and configuration for any one process applications**.**	10	**CO2**
3	**Supervisory Control and Data Acquisition (SCADA)** SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA, Protocol structure, Specifications of SCADA SCADA as a real time system, Communications in SCADA- types & methods used, components. SCADA Development for any one typical application Programming for GUI development using SCADA software.	07	**CO3**
4	**Distributed Control System** (**DCS**) Introduction to DCS. Evolution of DCS, DCS flow sheet symbols, architecture of DCS. Specifications of DCS. Introduction of Hierarchical control of memory: Task listing, Higher and Lower computer level task. Supervisory computer tasks DCS configuration. Supervisory computer functions, Control techniques, Supervisory Control Algorithm. DCS & Supervisory computer displays, advanced control Strategies, computer interface with DCS. DCS. System integration with PLCs computer: HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks. Introduction to DCS Programming, Function Block Diagram method for DCS programming.	10	**CO4**
5	**Database and Alarm Management MES, ERP** Database management,Philosophies of Alarm Management, Alarm reporting, types of alarms generated and acceptance of alarms. MES, Integration with enterprise system.	04	**CO5**
6	**Safety Instrumented System (SIS)** Need for safety instrumentation- risk and risk reduction methods, hazard	04	**CO6**

	analysis. Process control systems and SIS. Safety Integrity Levels (SIL) and availability. Introduction to the international functional safety standard IEC61508		

Internal 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.

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 weight age of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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 engineer's 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.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC7011	Biomedical Instrumentation	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC7011	Biomedical Instrumentation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
	Biomedical Instrumentation	3
Course Objectives	1. To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement 2. To make students understand the application of the various biomedical instruments in diagnosis, therapeutic and imaging fields	
Course Outcomes	The students will be able to: 1. Identify various Bio-potential with their specifications and perform their measurements. 2. Discuss various Physiological systems and to identify their parameters and related measurements. 3. Explain the principle and working of various cardiovascular parameters and their measurement techniques withapplications. 4. Distinguish between the various medical imaging techniques based onthe principles and concepts involved inthem. 5. Relate between the different life support instruments and to describetheir applications. 6. Describe the significance of electrical safety in biomedical measurement.	

Details of Syllabus:

Prerequisite: Biology and human physiology.

Module	Contents	Hrs.	CO mapping
1	**Bio-Potentials and their Measurement:** Structure of Cell, Origin of Bio-potential, electrical activity of cell and its characteristics and specifications. Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes.	5	CO1
2	**Physiological Systems and Related Measurement:** • Respiratory system- Physiology of respiration and measurements of respiratory relatedparameters. • Nervous system- Nerve cell, neuronalcommunication, nerve-muscle physiology, CNS, PNS. Generation of EEG and study of its characteristics. Normal and abnormal EEG, evoked potential and epilepsy. • Muscular system- Generation of EMG signal,specification and measurement. • Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias, Heart sound measurement. First aid to be given for heart attack patients. • Design of ECGamplifier.	10	CO2
3	**Cardiovascular Measurement:** • Blood Pressure- Direct and Indirecttypes. • Blood Flow- Electromagnetic and Ultrasonictypes. • Blood Volume- Types of Plethysmography. (Impedance) • Cardiac Output- Ficks method, Dye-dilution andThermo-dilution type	7	CO3
4	**Imaging Techniques: *** • X-Ray tube, X ray machine, Digital X Ray and its application. • CT Scan- CT Number, Block Diagram, scanning system andapplication. • Working principle of Ultrasound Imaging- Modes of scanning and theirapplication.	6	CO4
5	**Life support Instruments:** • Pacemaker- Types of Pacemakers, mode of pacing and its application. • Defibrillator- AC and DC Defibrillators and their application. • Heart Lung machine and its application duringsurgery. • Hemodialysis system and the precautions to be taken during dialysis. • Ventilator system and its important parameters formonitoring	9	CO5
6	**Significance of Electrical Safety:** • Physiological effects of electrical current, • Shock Hazards from electrical equipment and methods of accident prevention.	2	CO6

* **A Hospital Visit is recommended.**

Internal 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.

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 4-5 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.

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) JosephJ.CarrandJohnM.Brown,-IntroductiontoBiomedicalEquipment Technology, PHI/Pearson Education, 4th edition, 2001.
3) John E Hall, Gyton‘s- Medical Physiology, 12th edition,2011
4) L. E. Baker L. A. Geddes, -Principles of Applied Biomedical Instrumentation‖, John Wiley and Sons, 3rd Edition,1991.

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Th	Pract.	Tut.	Total
ISDOC 7012	Machine Learning	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC 7012	Machine Learning	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC 7012	Machine Learning	3
Course Objectives	1. To familiarize the student with basic concepts of Machine learning algorithms 2. To provide understanding of the concepts of regression and classification ML algorithms. 3. To introduce the students to the basic concepts and application of artificial neural networks	
Course Outcomes	Students will be able to: 1. Apply the basic concepts of various machine learning algorithms 2. Analyze the various supervised learning algorithms. 3. Analyze the various unsupervised learning algorithms. 4. Design machine learning algorithms based on artificial neural network. 5. Explain the concept and working of support vector machine 6. Apply machine learning algorithms for real time applications.	

Details of Syllabus:

Module	Contents	Hrs.	CO Mapping
1.	**Introduction to Machine Learning:** Introduction of Artificial Intelligence, Machine Learning and Deep Learning, Types of Machine Learning, Supervised Learning, Unsupervised Learning, Reinforcement, Design a Learning System: training data, concept representation, function approximation Perspectives and Issues in Machine Learning.	**05**	**CO1**
2.	**Supervised Learning:** Linear Regression (with one variable and multiple variables), Classification (Logistic Regression, Over fitting, Regularization).	**07**	**CO2**
3.	**Unsupervised Learning:** K-means and Hierarchical Clustering, Gaussian Mixture Models, Expectation Maximization (EM) algorithm, Model Selection, Dimensionality Reduction: Feature selection, Principal Component Analysis (PCA) and kernel PCA, Scaling.	**08**	**CO3**
4.	**Artificial Neural Networks:** The Neurons and the Brain, Neural Networks and Representation: Perceptron, Multilayer perceptron, Gradient Descent, nonlinear regression, back-propagation, Initialization, Training & Validation, decision trees for classification and regression, basic decision tree algorithm, issues in decision tree learning.	**08**	**CO4**
5.	**Support Vector Machines:** Functional and geometric margins, optimum margin classifier, constrained optimization, primal/dual problems, KKT conditions, dual of the optimum margin classifier, soft margins, kernels, quadratic programming, SMO algorithm.	**06**	**CO5**
6.	**Applying Machine Learning:** Machine Learning System Design, Error Analysis, Error Metrics for Skewed Classes, Trading Off Precision and Recall. **Machine Learning Applications:** Spam detection, Anomaly Detection, Recommender Systems.	**05**	**CO6**

Internal 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.

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 of4 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.

Text Books:

1. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, *"Foundations of Machine Learning (FOML)",* MIT Press, 2012
2. David Barber, *"Bayesian Reasoning and Machine Learning",* Cambridge University Press, 2007.
3. Tom Mitchell, *"Machine Learning",* McGraw Hill, 1988.

Reference Books:

1. Ian Goodfellow,Yoshua Bengio and Aaron Courville, *"Deep Learning (DL)",* MIT Pess, 2016.
2. Shai Shalev-Shwartz and Shai Ben-David, *"Understanding Machine Learning: From Theory to Algorithms (UML)"*, Cambridge University Press, 2014.

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Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC 7013	Advanced Control Systems	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC 7013	Advanced Control Systems	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC7013	Advanced Control Systems	3
Course Objectives	1. To familiarize the student with nonlinear phenomena. 2. To provide the students an understanding of stability and behavior of nonlinear systems near equilibrium points in phase plane. 3. To analyze stability of nonlinear systems using describing function technique in complex-plane. 4. To introduce the model predictive control to the students.	
Course Outcomes	Students will be able to: 1. Distinguish between linear and nonlinear systems. 2. Compute or draw the state trajectory in phase-plane to analyze the behavior of nonlinear systems. 3. Linearize the nonlinear system and identify the nature of singular points. 4. Construct the Lyapunov function to determine the stability of equilibrium. 5. Determine the stability of the system in frequency domain via describing functions. 6. Design IMC-PID controller to system with uncertainties and disturbances.	

Details of Syllabus:

Prerequisite: Knowledge of linear control theory.

Module	Contents	Hrs.	CO mapping
1	**Nonlinear Control Systems** Definition of nonlinear system, difference between linear and nonlinear systems, nonlinear models and nonlinear phenomena. Common physical nonlinearities - relay, saturation, dead-zone, friction, hysteresis, backlash and composite nonlinearities, jump resonance.	**5**	**CO1**
2	**Phase Plane Analysis** Basic concepts-phase trajectories, phase portrait. Qualitative behaviour of linear systems, multiple equilibria, qualitative behaviour near equilibrium points, limit cycles. Construction of phase trajectory by analytical method and graphically by delta method.	**9**	**CO2**
3	**Linearization** Jacobian Linearization, Concept of relative degree, zero dynamics of a nonlinear system. Input-output linearization using feedback for systems with no zero dynamics.	**5**	**CO3**
4	**Lyapunov Stability Analysis** Stability of equilibria, Asymptotic stability, Lyapunov stability theorems, Stability analysis of linear systems, Construction of Lyapunov functions using Krasovskii method and variable gradient method.	**8**	**CO4**
5	**Describing Function Analysis** Fundamentals of describing function. Describing Functions of saturation, dead-zone, relay and their combinations. Stability analysis of nonlinear systems via describing function method.	**8**	**CO5**
6	**Internal Model Control** Introduction to Model-Based Control, Open loop controller Design, Model Uncertainty and Disturbances, Development of IMC structure, IMC-Based PID Controller Design	**4**	**CO6**

Internal 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.

Theory Examination:

1. Question paper will comprise 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.

Text Books:

1. I. J. Nagrath and M. Gopal, Control System Engineering, 3rd Edition, New Age International (P) Ltd., Publishers - 2000.
2. Hassan Khalil, Nonlinear Systems, 3rd edition, paperback edition, 2014.
3. B. WayneBequette, Process Control: Modeling, Design, and Simulation, Prentice Hall PTR, 2002.
4. K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002.

Reference Books:

1. Pierre R. Belanger, "Control Engineering", Saunders college Publishing.
2. Alberto Isidori, Nonlinear Control Systems, CSE book series, Springer-Verlag London 1995.
3. Dr. K.P. Mohandas, "Modern Control Engineering", revised edition, Sanguine Publishers, Bangalore, 2006.
4. Gene F. Franklin, J David Powell, Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", 5th edition Pearson Educations.
5. Shankar Sastry, Marc Bodson, "Adaptive Control", Prentice Hall of India (P) Ltd., 1993.
6. John Doyle, Bruce Francis, Allen Tannenbaum, "Feedback Control Theory".
7. Pierre R. Belanger, "Control Engineering", Saunders college Publishing
8. Norman Nise, "Control System Engineering", 4th edition Wiley International Edition.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC7014	Advanced Microcontroller	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC7014	Advanced Microcontroller	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC7014	Advanced Microcontroller	3
Course Objectives	1. To introduce the outline architecture of ARM microcontroller including basics of pipelines, registers, exception modes, etc. 2. Develop program ARM Cortex M3 using the various instructions for different applications and understand the basic hardware components. 3. Understand and design real time operating systems which are backbone of embedded industry. 4. To introduce the setup and operate the Raspberry Pi.	
Course Outcomes	Students will be able to: 1. Describe ARM microcontroller Architecture and Operation. 2. Discuss the overview of Cortex-M3 processor. 3. Develop application using Cortex-M3 processor. 4. Explain the memory protection units and the other features of Cortex-M3 Processor. 5. Describe the principle of working of RTOS and related tasks. 6. Build efficient embedded system using Raspberry Pi.	

Details of Syllabus:

Prerequisite: Knowledge of High-level language programming.

Module	Contents	Hrs.	CO mapping
1	**ARM Architecture**: Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture.	**6**	**CO1**
2	**Overview of Cortex-M3**: Cortex-M3 Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence. Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions.	**10**	**CO2**
3	**Cortex-M3 Implementation Overview** Pipeline, Block Diagram, Bus Interfaces on Cortex-M3, I-Code Bus, D-Code Bus, System Bus, External PPB and DAP Bus, Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behaviour, Fault Exceptions and Interrupt Latency.	**8**	**CO3**
4	**Memory Protection Unit and other Cortex-M3 features** MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication.	**5**	**CO4**
5	**Introduction to Real Time Operating System:** Tasks and task states, task and data, Semaphores and shared data. Multitasking operating systems, Context switching, task tables, and kernels, Task swapping methods (Time slice, Pre-emption, Co-operative multitasking). Scheduler algorithms (Rate monotonic, Deadline monotonic scheduling) Priority inversion, Tasks, threads and processes, Exceptions, Example of any tiny RTOS.	**6**	**CO5**
6	**Introduction to Raspberry Pi**: Raspberry Pi Hardware, Raspberry Pi Accessories Raspberry Pi Software, communicating with the Raspberry Pi, Configuring the Raspberry Pi.	**4**	**CO6**

Internal 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.

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.

Text Books:

1. The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010.
2. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
3. David Seal "ARM Architecture Reference Manual", 2001 Addison Wesley, England; Morgan Kaufmann Publishers
4. Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", 2006, Elsevier.

Reference Books:

1. Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education.
2. Cortex-M series-ARM Reference Manual.
3. Cortex-M3 Technical Reference Manual (TRM)
4. Arnold. S. Berger, "Embedded Systems Design - An introduction to Processes, Tools and Techniques", Easwer Press.
5. Raj Kamal, "Microcontroller - Architecture Programming Interfacing and System Design" 1st Edition, Pearson Education.
6. Derek Molloy, "Exploring Raspberry Pi, Interfacing to the Real World with Embedded Linux", 2016.
7. Simon Monk, "Programming the Raspberry Pi, Getting Started with Python", McGraw Hill, 2006.

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application-oriented information.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL701	Instrumentation Project Documentation and Execution Lab Practice	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL701	Instrumentation Project Documentation and Execution Lab Practice	--	--	--	--	25		25	50

Subject Code	Subject Name	Credits
	Instrumentation Project Documentation and Execution Lab Practice	1
Course Objectives	1. To provide knowledge of types and execution of I&C type project 2. This Course aims to explain Project deliverables and engineering activities of project documentation. 3. To get acquainted with commercial software used for documentation.	
Course Outcomes	The students will able to- 1. Apply standards used in instrumentation project for preparation of deliverables**.** 2. Interpret, design and construct documents such as PFD, P&ID, Index sheet. 3. Apply ISA specification data sheet / loop standard, to prepare Instrument specification sheet and construct loop wiring diagram. 4. Interpret, design and construct Hook-up diagram, and develop skill to prepare different project schedule. 5. Select and apply procurement, installation procedure and pre-commissioning and commissioning activities with Inspection. 6. Select and support documentation software packages used in industry.	

Syllabus: Same as that of Subject ISC701 Instrumentation Project Documentation and Execution.

List of Experiments

Sr No	Experiments	CO Mapping
1	# To study and draw Instrumentation symbols: ISA symbols	CO1
2	# To study and prepare Process Flow Diagram.	CO2
3	# To develop P&ID diagram.	CO2
4	To prepare instrument index sheet for tags used in P&ID.	CO2
5	# To prepare loop wiring diagram of any electronic/ pneumatic loop.	CO3
6	Study and prepare specification sheets for sample instruments.	CO3
7	# To prepare Installation details (Hook-up diagram) for DPT/ Thermowell	CO4
8	To Study and preparation of Cable schedule	CO4
9	To Learn procedure to perform pre-commissioning activities	CO5
10	To study various software packages used for project documentation.	CO6
11	To prepare documents for Procurement activities: Inquiry, Quotation, Comparative statement, Purchase orders	CO5

 # Students should prepare it on A3/A1 size drawing paper

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL702	Process Automation - Lab Practice	-	02	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			Endsem exam	Term work	Pract. And oral	Oral	Total
		Test1	Test2	Avg.					
ISL702	Process Automation – Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	credits
ISL702	Process Automation – Lab Practice	1
Course objective	1. To give the students fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA. 2. To impart the knowledge about the architecture, working of PLC, SCADA and DCS 3. To make the students capable to apply knowledge to identify hardware and software requirements of PLC, SCADA and DCS 4. To give the students a comprehension of the aspects related to Safety Instrumented system (SIS).	
Course Outcome	The students will be able to 1. Define automation, it's need, importance and applications in industry. 2. Design PLC based application by proper selection and sizing criteria, developing GUI and ladder program. 3. Develop any application based on SCADA along with GUI using SCADA software. 4. Develop DCS program using Function Block Diagram (FBD) method. 5. Describe database and alarm management system. 6. Identify the components of SIS, risk reduction methods, evaluation of SIL (Safety Integrity Levels)	

Syllabus: Same as that of Subject ISC702 Process Automation.

List of Laboratory Experiments/Assignments:

Sr. No.	Detailed Content	CO Mapping
1.	Demonstration of PLC	**CO2**
2.	Processing of sensor signals by the PLC to drive various end effectors such as pneumatic/electric/hydraulic.	**CO2**
3.	PLC programs for process control applications (minimum 4 nos.)	**CO2**
4.	GUI development for anyone application using SCADA software.	**CO3**
5.	DCS programming using Function block diagram method	**CO4**
6.	Assignment/Exercise based on Automation Fundamentals	**CO1**
7.	Assignment/Exercise based on DCS	**CO3**
8.	Assignment/Exercise based on SCADA	**CO4**
9.	Assignment based on Database and Alarm management	**CO5**
10.	Assignment based on Safety Instrumented System	**CO6**

Any other experiments/assignments based on syllabus which will help students to understand topic/concept.

Industrial visit is advised to understand the Process Automation subject.

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

Term Work:
Term work shall consist of minimum 4 experiments and 4 assignments.

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

Laboratory work (Experiments/Assignments): 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensure the satisfactory performance of Laboratory work and minimum passing in the term work.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL7031	Biomedical Instrumentation Lab practice	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL7031	Biomedical Instrumentation Lab practice	--	--	--	--	25	-	25	50

Subject Code	Subject Name	Credits
ISL7031	Biomedical Instrumentation Lab Practice	1
Course objective	1. To make students perform experiments based on the principle and working of various Biomedical Instruments used for Bio-potential measurements 2. To develop skills in the design of various biomedical instruments used in diagnosis and life-support.	
Course Outcome	Students will be able to- 1. Measure and identify various Bio-potentials with their specifications. 2. Observe and plot various Physiological parameters with their specifications. 3. Measure the various cardiovascular parameters by designing the related circuitry. 4. Distinguish between the various medical imaging techniques by comparing, principle and concept involved in each of the technique 5. Realize the circuitry of different life support instruments, like pacemaker, defibrillator. 6. Describe the significance of electrical safety in bio medical measurement.	

Syllabus: Same as that of Subject ISDOC7011 Biomedical Instrumentation.

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	Study of electrodes for various biomedical applications.	**CO1**
2.	Demonstration and working of instruments like EMG and EEG.	**CO2**
3.	Demonstration and working of instruments like ECG and PCG.	**CO2**
4.	To measure Blood pressure by indirect method.	**CO3**
5.	To study Pacemaker and various waveforms or Design and implement pacemaker circuit.	**CO5**
6.	To study Defibrillator and voltage waveforms or Design and implement Defibrillator circuit.	**CO5**
7.	Design of ECG amplifier and testing of gain frequency response with weak input signal.	**CO3**
8.	To design and implement ECG signal conditioning circuits with different parameter.	**CO3**
9.	To design and implement EMG Quantification circuit.	**CO2**
10.	To study Hemodialysis, Heart Lung Machine based models.	**CO5**
11.	ECG simulation on PC / Microcontroller.	**CO3**
12.	Study of working of pulse oximeter / Heart rate meter.	**CO3**
13.	To study respiration rate meter / respiration parameter measurement.	**CO2**
14.	Study on Medical Imaging Techniques	**CO4**
15.	Study on Electrical Safety	**CO6**

Any other experiment based on syllabus which will help students to understand topic/concept.

Practical and Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum 08 experiments from the above given list (All six COs must be covered) and few assignments.
Hospital visit report must be attached.

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

Laboratory work (Experiments/ Assignments):10 Marks
Laboratory work (Journal/visit) : 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Th	Pract.	Tut.	Th	Pract.	Tut.	Total
ISL7032	Machine Learning Lab	-	2	-	-	2	-	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL7032	Machine Learning Lab	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL7032	Machine Learning Lab	2
Course Objectives	1. To familiarize the student with basic concepts of Machine learning algorithms 2. To provide understanding of the concepts of regression and classification ML algorithms. 3. To introduce the students to the basic concepts and application of artificial neural networks	
Course Outcomes	Students will be able to: 1. Develop programs based on supervised learning. 2. Implement programs based on unsupervised learning. 3. Execute programs on data classification. 4. Develop programs based on artificial neural networks. 5. Execute programs based on support vector machine. 6. Develop applications using machine learning.	

Syllabus: Same as that of Subject ISDOC7012 Machine Learning.

List of the Laboratory Experiments:

Sr. No.	Contents	CO Mapping
1.	Write a python program to implement linear regression with one variable for given dataset.	**CO1**
2.	Write a python program to implement linear regression with two variables for given dataset.	**CO1**
3.	Implement logistic regression and apply it to two different datasets.	**CO2**
4.	Implement one-vs-all logistic regression and neural networks to recognize hand-written digits dataset.	**CO3**
5.	Implement the backpropagation algorithm for neural networks and apply it to the task of hand-written digit recognition.	**CO4**
6.	Implement regularized linear regression and use it to study models with different bias-variance properties.	**CO1**
7.	Implement support vector machines (SVMs) to build a spam email classifier.	**CO5**
8.	Implement the K-means clustering algorithm and apply it to compress an image.	**CO2**
9.	Implement the anomaly detection algorithm and apply it to detect failing servers on a network	**CO6**
10.	Implement the Recommender Systems algorithm.	**CO6**

Any other experiment based on the syllabus will help students to understand the topic/concept.

Practical and Oral Examination:

Practical and Oral examinations will be based on the entire syllabus.

Term Work:

Term work shall consist of minimum 8 experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments): 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.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL7033	Advanced Control System Lab practice	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL7033	Advanced Control System Lab practice	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL7033	Advanced Control System	1
Course Objectives	1. Students should be able to examine stability of limit cycle 2. The students should be able to examine stability of nonlinear system using DF techniques and Lyapunov's functions 3. The students should be able to design the IMC structure. 4. The students should able to examine the stability using sliding mode control 5. Students can be able to optimize the any particular system.	
Course Outcomes	Students will be able to- 1. Construct the phase-plane trajectories using Delta Method. 2. Classify stability of limit cycle as per obtained response of the system 3. Linearize the nonlinear system, identify the singular point and its nature. 4. Derive DF for common nonlinearities and investigate stability of system with limit cycle. 5. Investigate the stability of nonlinear system using Lyapunov's function 6. Design the IMC based PID controller.	

Syllabus: Same as that of Subject ISDOC7013 Advanced Control System.

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	Construct the trajectory for system represented by second order differential equation and for any initial condition by using Delta Method.	CO1
2.	Validate behaviour of limit cycle with the help of Vander Pol's equation.	CO2
3.	Linearize the given nonlinear system and identify the singular points and their nature.	CO3
4.	Derivation of DF for nonlinearities – relay with saturation, relay with dead-zone, dead-zone and saturation etc.	CO4
5.	Investigate the stability of system with nonlinearities – relay, saturation, dead-zone and existence of limit cycle using DF technique.	CO4
6.	Verify Sylvester theorem for the definiteness of the Lyapunov Function.	CO5
7.	Determine the stability of the system and construct the Lyapunov function for Linear Time invariant system.	CO5
8.	Determine the stability of the system and construct the Lyapunov function by using Krasovskii method	CO5
9.	Determine the stability of the nonlinear system by using Variable Gradient method	CO5
10.	Observe the effect of filter tuning parameter on step response of the first and second order systems.	CO6
11.	Design of IMC controller for a system subject to step input.	CO6
12.	Design of IMC controller for a system subject to ramp input.	CO6
13.	Design of IMC based PID controller.	CO6
14.	Design of IMC controller for delay and non-minimum phase systems.	CO6

Any other experiment based on syllabus which will help students to understand topic/concept.

Practical and Oral Examination:

Practical and Oral examination will be based on entire syllabus of **ISDOC7013 Advanced Control System**.

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 : 05 Marks

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL7034	Advanced Microcontroller Lab Practice	--	2	--	--	1	--	1

Subject Code	Subject Name	Theory (out of 100)				Term work	Pract. / Oral	Total
		Internal Assessment			End sem Exam			
		Test1	Test2	Avg.				
ISL7034	Advanced Microcontroller Lab Practice	--	--	--	--	25	25	50

Subject Code	Subject Name	Credits
ISL7034	**Advanced Microcontroller Lab Practice**	**1**
Course Objectives	1. To introduce the outline architecture of ARM microcontroller including basics of pipelines, registers, exception modes, etc. 2. Develop program ARM Cortex M3 using the various instructions for different applications and understand the basic hardware components. 3. Understand and design real time operating systems which are backbone of embedded industry. 4. To introduce the setup and operate the Raspberry Pi.	
Course Outcomes	Students will be able to: 1. Interpret ARM microcontroller Architecture and Operation. 2. Use Cortex-M3 processor. 3. Address the implementation of Cortex-M3 processor for broad range of devices. 4. Explain the memory protection units and the other features of Cortex-M3 processor. 5. Introduce real time operating system and describe the principle of working of RTOS and related tasks. 6. Develop a platform for building low cost highly capable embedded system using Raspberry Pi.	

Syllabus: Same as that of Subject ISDOC7014 Advanced Microcontroller.

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	Demonstration of ARM Architecture	CO1
2.	Implement arithmetic Operation using ARM processor	CO2
3.	Implement logical Operation using ARM processor	CO2
4.	Code conversion Operation using ARM processor	CO2
5.	Implementation of program using Cortex-M3 processors	CO3
6.	Interfacing I/Os using Cortex-M3 processors	CO3
7.	Interfacing LM35 (Temperature Sensor) using Cortex-M3 processors	CO3
8.	Develop applications ofMPU and other Cortex-M3.	CO4
9.	Case study on various types of RTOS.	CO5
10.	To develop a Python program for controlling an LED with a switch.	CO6
11.	To develop a Python program for switching LED based on LDR reading.	CO6

Any other additional experiments/assignments based on syllabus which will help students to understand topic/concept.

Practical/Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum 8 experiments as per above list.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments): 10 Marks
Laboratory work (programs / journal): 10 Marks
Attendance: 5 Marks

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISP701	Major Project – I	--	6#	--	--	3	--	3

# Indicates workload of Learner (Not Faculty)

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISP701	Major Project – I	--	--	--	--	50	--	50	100

Subject Code	Subject Name	Credits
ISP701	Major Project – I	3
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 9 Demonstrate project management principles during project work.	

Guidelines for Major Project

- Students should form groups with minimum 2(two) and not more than 4 (four)

- Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on log book	: 15
Marks awarded by review committee	: 15
Quality of Project report	: 20

Review/progress monitoring committee may consider following points for assessment.

- In VII semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalization of problem
    - Second shall be on finalization of proposed solution of problem.

Assessment criteria of Major Project-I

Major Project-I shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.

- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.

- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Major Project-I shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Program Structure for Final Year B.E Instrumentation Engineering
(With Effect from 2022-2023)
Scheme for Semester -VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ISC801	Instrument and System Design	3	--	3	--	3
ISDOC801X	Department Optional Course– 4	3	--	3	--	3
ISDOC802X	Department Optional Course– 5	3	--	3	--	3
ISIOC801X	Institute Optional Course–2	3	--	3	--	3
ISL801	Instrument and System Design– Lab	--	2	--	1	1
ISL802X	Department Optional Course -4 - Lab	--	2	--	1	1
ISP801	Major Project-II	--	12#	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ISC801	Instrument and System Design	20	20	20	80	3	--	--	100
ISDOC801X	Department Optional Course– 4	20	20	20	80	3	--	--	100
ISDOC802X	Department Optional Course– 5	20	20	20	80	3	--	--	100
ISIOC801X	Institute Optional Course–2	20	20	20	80	3	--	--	100
ISL801	Instrument and System Design –Lab	--	--	--	--	--	25	25	50
ISL802X	Department Optional Course -4 - Lab	--	--	--	--	--	25	25	50
ISP801	Major Project-II	--	--	--	--	--	50	100	150
Total		**--**	**--**	**80**	**320**	**--**	**100**	**150**	**650**

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC801	Instrument and System Design	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISC801	Instrument and System Design	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC801	Instrument and System Design	3
Course Objectives	1. To impart knowledge of selection and design considerations of transducers along with their calibration techniquess. 2. To make the students capable of sizing the control valve. 3. To impart the students' knowledge about the types, sizing of control panels, and standards. 4. To make the students capable to design electronic products, control room layout, and its environment. 5. To familiarize students with the concept of reliability engineering.	
Course Outcomes	The students will be able to: 1. Select, design and calibrate transducers 2. Select and size the control valves and actuators. 3. Estimate valve noise and predict cavitation. 4. Apply knowledge to design the control panels and control room. 5. Design electronic products and enclosures. 6. Define the terms used in Reliability engineering.	

Details of Syllabus:

Prerequisite: Knowledge of transducers and control valves

Module	Contents	Hrs.	CO mapping
1	**Design of Transducers:** An overview of static and dynamic performance characteristics of instruments. Selection criteria, design considerations, calibration and installation for flow, temperature, pressure and level transducers.	07	CO1
2	**Design of Control Valve:** Review of flow equations. Valve selection and sizing for liquid service, gas or vapor service, flashing liquids and mixed phase flow, Actuator sizing. Selection criteria and design consideration of pressure safety relief valves and rupture discs.	12	CO2
3	**Cavitation and Noise estimation:** Control valve noise, sources of noise, noise prediction, abatement of noise. Control valve cavitation, effects, preventing cavitation, Prediction of cavitation.	07	CO3
4	**Control Panel and Control room design** Panel selection-size, type, construction and IP classification, NEMA standard. GA Diagrams, Power wiring and distribution, Earthing scheme. Panel ventilation, cooling and illumination. Operating consoles-ergonomics. Wiring accessories- ferules, lugs, PVC ducts, spiral etc. Wire sizes and color coding. Packing, Pressurized panels- X, Y, and Z Purging for installation in hazardous areas. Ex-proof panels. Intrinsic safe (IS) and non-intrinsic safe (non-IS) cables design. Control Room Design: Layout and environment, modern control room layout	05	CO4
5	**Electronic product design:** System Engineering, Ergonomics, phases involved in electronic product design. **Enclosure Design:** Packing and enclosures design guidelines, Grounding and shielding, front panel and cabinet design of an electronic product.	04	CO5
6	**Reliability engineering:** Reliability concepts, causes of failures, bath tub curve, Quality and reliability, MTTF, MTBF, and MTTR. Availability and Maintainability. Redundancy and redundant systems.	04	CO6

Internal 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 Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20Marks.
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 weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

Text Books:

1. Kim R Fowler, Electronic Instrument Design, Oxford University-1996.
2. Bal Guruswamy E,"Reliability"TataMcGraw-HillPub.co.NewDelhi,1999.

Reference Books:

1. Les Driskell, "Control valve sizing", ISA.
2. Bela G. Liptak, "Instrument Engineer 's Hand Book – Process Control", Chilton Company, 3rdEdition, 1995
3. Andrew Williams, ―Applied instrumentation in the process industries‖, 2nd Edition, Vol. 1 &3, Gulf publishingcompany,1979.
4. Mourad Samiha & Zorian Yervant, "Principles of Testing Electronic Systems", New York. John Wiley & Sons,2000.
5. Lewis EE, "Introduction to Reliability Engineering" (2nd), NewYork.JohnWiley&Sons,1996.
6. Anand M.S, "Electronic Instruments and Instrumentation Technology", New Delhi. Prentice Hall of India, 2004.
7. "Manual on product design": IISc C.E.D.T.
8. R. W. Zape, –" Valve selection hand book" third edition, Jaico publishinghouse,2003.
9. Curtis Johnson, "ProcessControlInstrumentationTechnology",PHI/PearsonEducation2002.

Subject code	Subject Name	Teaching scheme			Credit assigned		
		Theory	Pract.	Tut.	Theory	Pract.	Tut.
ISDOC8011	Digital Control Systems	3	-	-	3	-	-

Sub Code	Subject Name	Examination scheme						
		Theory (out of 100)				Term work	Pract. and Oral	Oral
		Internal Assessment			End sem Exam			
		Test1	Test2	Avg.				
ISDOC8011	Digital Control Systems	20	20	20	80	-	-	-

Subject Code	Subject Name	Credits
ISDOC 8011	Digital Control Systems	3
Course Objectives	1. To familiarize the students with the basic knowledge of discretization. 2. To familiarize the students with the discrete-time representations of systems for the analysis and design of the digital control. 3. To equip the students to determine the stability of the digital control system.	
Course Outcomes	Students will be able to: 1. Distinguish the continuous-time and discrete-time control systems and their working principles. 2. Discretize the given continuous-time system. 3. Represent the given discrete-time system in frequency and time-domain. 4. Perform the transformation of the system in to canonical forms and compute the state trajectory via state transition matrix. 5. Determine the stability of discrete-time control systems in frequency and time-domain. 6. Design controller and observer for discrete-time control systems.	

Details of Syllabus:

Prerequisite: Knowledge of basic control theory of continuous-time control systems.

Module	Contents	Hrs.	CO mapping
1	**Introduction** Block diagram of a typical digital control system, Practical examples of digital control systems, advantages and limitations of discrete-time control systems over continuous-time control system. Continuous time signals versus discrete-time signals, data conversion and quantization, sampling as impulse modulation, sampling period considerations, aliasing and folding, reconstruction of analog signals, zero order hold, first order hold.	6	CO1
2	**Principles of Discretization** Impulse sampling, data hold via zero-order hold and first-order hold with their transfer functions, discretization of the continuous-time control system using- impulse invariance technique, step-invariance, finite difference approximation of derivatives and bilinear transformation, Mapping between s-plane and z-plane.	6	CO2
3	**Representation of digital control systems** Linear difference equations, pulse transfer function, input output model, examples of first and second order continuous and discrete time systems, Construction of signal flow graph (SFG) for discrete-time control systems, computation of pulse transfer function via SFG.	6	CO3
4	**State-space Analysis of Discrete-time Systems** State-space space representation of discrete-time system. State-space representation of the system in canonical forms namely- controllable, observable and diagonal/Jordan canonical forms. Similarity transformations, non-uniqueness of state-space models, invariance of eigenvalues under similarity transformation. System transformation to diagonal/Jordan form. State transition matrix (STM), solution to the discrete-time state equations via STM.	7	CO4
5	**Stability Analysis of Discrete-time Systems** Stability analysis of the system system via frequency-domain approaches-analysis via pole locations in z-plane, Jury's stability test, bilinear transformation and Routh stability criterion. Stability analysis of the system system via time-domain Lyapunov approach- Lypunov functions, Lyapunov stability theorems, Lyapunov equation for linear-time invariant discrete-time systems.	6	CO5
6	**State Feedback Controller and Observer Designs for of Discrete-time Systems** Concepts of controllability, stabilizability, observability and detectability. Principle of duality. Effect of discretization of continuous time system on controllability and observability properties. Construction of a transformation to transform the system into controllable and observable forms for linear time-invariant single-input single-output systems. Design of state feedback control, Ackermann's formula to compute the state feedback gain for pole-placement, deadbeat control design. State observers, design of full state observer using pole-placement methods.	8	CO6

Internal 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.

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.

Text Books:

1. Katsuhiko Ogata, Discrete Time Control Systems, Pearson Education Inc., 1995.
2. M. Gopal, Digital Contol and State Variable Methods, Tata McGraw Hill, 2ndEdition, 2003.
3. Benjamin Kuo, "Digital Control Systems", Saunders College Publishing, 1992.

Reference Books:

1. G. Franklin, J. Powel, M. Workman, *Digital Control of Dynamic Systems,* Pearson Education, 3rd Edition, 2003.
2. M. Fadali Antonio Visioli, Digital control Engineering Analysis & Design, Academic press, 2012**.**
3. Richard J. Vaccaro, "Digital Control", McGraw Hill Inc., 1995.
4. Ashish Tewari, "Modern Control System Design with MATLAB", John Wiley, Feb. 2002.
5. Joe H. Chow, Dean K. Frederick, "Discrete Time Control Problems using MATLAB", Thomson Learning, 1st Edition, 2003.

Course code	Subject Name	Teaching scheme			Credit assigned			
ISDOC8012	Expert System	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment (20)			End sem Exam				
		Test 1	Test 2	Avg.					
ISDOC8012	Expert System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISDLO8012	Expert System	3
Course objective	1. To provide an understanding on the fundamentals of Artificial Intelligence and Expert System. 2. To provide an understanding on the fundamentals of neural network. 3. To provide an understanding on the fundamentals of fuzzy systems. 4. To provide an understanding of Neuro fuzzy system. 5. To provide an understanding of applications based on Artificial Intelligence and Expert System.	
Course Outcome	The students will able to- 1. Interpret the concepts of Artificial Intelligence and Expert System. 2. Explain artificial neural network. 3. Compare advanced artificial neural network algorithms. 4. Define Fuzzy set, rules and membership function and also defuzzification for a given problem. 5. Examine various hybrid systems. 6. Apply AI and expert systems algorithms for different domains.	

Details of syllabus:

Prerequisite: Linear algebra, Python Programming, knowledge of control systems, optimization technique.

Module	Contents	Hrs	CO Mapping
1	**Introduction to Artificial Intelligence and Expert System** Evolution, Definition, Features, Importance, Advantages, Disadvantages, limitations/issues, comparison.	04	CO1
2	**Artificial Neural Network (ANN)** Evolution, Biological Inspiration, Single and Multi-Input Neurons, Weights, Transfer Functions, Momentum, Neural network learning rule, Back propagation algorithm (BPA), Performance Index, Batch vs. Incremental Training, Single layer and multi-layer Perceptron classifiers.	08	CO2
3	**Advance Neural Networks** Recurrent Neural Networks, LSTM, Gated RNN, Convolutional Neural Networks, Auto Encoders.	08	CO3
4	**Fuzzy Logic** Fuzzy sets, Operation on Fuzzy sets, Fuzzy membership functions, Rule base, De-fuzzification, Mamdani and Sugeno Fuzzy Inference System.	07	CO4
5	**Hybrid Systems** Neuro fuzzy systems –Adaptive neuro fuzzy inference system (ANFIS) – Optimization of membership function and rule base. Familiarization of ANFIS Tool Box.	05	CO5
6	**Case study** Problem Selection, Conceptualization, Formalization, Knowledge Acquisition, Prototype Construction, Implementation, Evaluation. Process control, Electrical Engineering, Speech processing, medical diagnosis	07	CO6

Internal 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.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20Marks.
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 to5 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.

Text Books:

1. Gupta, Itisha, and Garima Nagpal. *Artificial Intelligence and Expert Systems*. Stylus Publishing, LLC, 2020.
2. Hagan, Martin T., Howard B. Demuth, and Mark Beale. *Neural network design*. PWS Publishing Co., 1997.
3. Stamatios V. Kartalopolous, .Understanding Neural Network and Fuzzy Logic., PHI PvtLtd.
4. Kishan Mehrotra, .Elements of ANN., 2nd Editon, Penram International Publishing(I) Pvt.Ltd.
5. Donald A.Waterman, ‒A Guide to Expert Systems‖,Addison-WesleyPublishing Company

References Books:

1. Laurene. V, Fausett, ‒Fundamentals of Neural Networks, Architecture, Algorithms,and Applications‖, Pearson Education,2008.
2. Timothy.J,Ross,―FuzzyLogicwithEngineeringApplications‖,Wiley,ThirdEdition, 2010.
3. Zimmermann. H.J, "Fuzzy set theory-and its Applications"- Springerinternational edition, 2011.
4. Miller W.T, Sutton .R.Sand Webrose .P.J,‒Neural Networksfor Control‖, MITPress, 1996.
5. Kevin Nightand ElaineRich, Nair B.,‒ArtificialIntelligence (SIE)‖, McGraw Hill-2008.
6. Dan W. Patterson, ‒Introduction to AIand ES‖, Pearson Education, 2007.(Unit-III).
7. PeterJackson, ‒Introduction toExpert Systems‖,3rd Edition, Pearson Education,2007.
8. Stuart Russel and PeterNorvig ‒AI– A ModernApproach‖, 2nd Edition,Pearson Education2007
9. DeepakKhemani ‒ArtificialIntelligence‖, TataMcGrawHill Education2013.
10. LauranceFausett,EnglewoodCliffs,N.J.,_FundamentalsofNeuralNetworks‘,Pearson Education,1992.
11. TimothyJ.Ross,_FuzzyLogicwithEngineeringApplications‘,TataMcGrawHill,1997.
12. S.N.Sivanandam and S.N.Deepa, Principles of Soft computing, Wiley India Edition,2nd Edition,2013
13. Simon Haykin, _Neural Networks‘, Pearson Education,2003.
14. John Yen & Reza Langari, _Fuzzy Logic – Intelligence Control & Information‘,Pearson Education,New Delhi, 2003.
15. M.Gen and R,Cheng, Genetic algorithms and optimization, Wiley Series in Engineering Design and Automation, 2000.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC8013	Digital Image Processing	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC8013	Digital Image Processing	20	20	20	80	25	-	25	150

Subject Code	Subject Name	Credits
ISDOC8013	Digital Image Processing	3
Course Objectives	1. To introduce the basic elements of digital image processing. 2. To familiarize with 2-D Transforms of digital images. 3. Ability to use image enhancement and segmentation techniques. 4. To analyze image compression and object recognition algorithms.	
Course Outcomes	Students will be able to- 1. Interpret the basic elements of digital image processing. 2. Analyze digital images using 2-D transforms. 3. Apply spatial filtering and image enhancement techniques in the frequency domain. 4. Analyze image segmentation techniques. 5. Apply different image compression techniques. 6. Recognize and classify objects and patterns in digital images.	

Module	Contents	Hrs.	CO mapping
1.	**Fundamentals of Image Processing:** Digital image representation, fundamental steps in image processing, Elements of digital image processing systems, Image fundamentals: Gray, Color and Black and white. Color image models: RGB, CMY, HIS and other models. Various Image Format, Sampling and quantization, Relationship between pixels, Statistical parameters (with respect to DIP): Mean, standard deviation, variance, SNR, PSNR etc.	06	CO1
2.	**Image transforms:** Basic transformations, Perspective transformation, 2-D Transforms: Fourier transform, Discrete cosine transform, Short time Fourier transform, Gabor transform, Radon transform, SVD, Wavelet Transforms, Hough Transform, Watershed Transform	07	CO2
3.	**Image Enhancement:** Enhancement by point processing, spatial filtering, enhancement in the frequency domain. Contrast intensification: linear stretching, non-linear stretching, histogram specification, low contrast stretching. Smoothing: Image averaging, mean filter, order statistics filter, edge preserving smoothing. Sharpening: High pass filtering, homomorphic filtering.	07	CO3
4.	**Image Analysis and Segmentation:** Detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Introduction Classifiers.	06	CO4
5.	**Image Compression:** Need, Lossy and lossless compression, Huffman, RLE, LZW, Vector Quantization, Shift codes, Arithmetic coding, BTC, Transform based compression: JPEG, MPEG, JPEG 2000, etc., properties of image compression schemes.	06	CO5
6.	**Object Recognition and Applications:** Feature extraction, Patterns and Pattern Classes, Representation of Pattern classes, Types of classification algorithms, Minimum distance classifier, Correlation based classifier, Bayes classifier. Applications: Biometric Authentication, Character Recognition, Content based Image Retrieval, Remote Sensing, Medical application of Image processing	07	CO6

Internal 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.

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.

Text Books

1. Rafael C. Gonzalez and Richard E. Woods, *"Digital Image Processing",* Pearson Education, 2007.
2. S Sridhar, *"Digital Image Processing",* Oxford University Press, 2016.
3. A. K. Jain, *"Fundamentals of Digital Image Processing",*PHI, 1994
4. W. K. Pratt, *"Digital Image Processing",*John Wiley and Sons, 1996

Reference Books

1. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, *"Digital Image Processing Using MATLAB",* Tata McGraw Hill Publication, 2009.
2. S Jayaraman, S Esakkirajan, T Veerakumar, *"Digital Image Processing",* Tata McGraw Hill, 2019.

Course Code	Course Name	Teaching Scheme (Contact HOURS)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut	Total
ISDOC8014	Internet of Things (IOT)	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC8014	Internet of Things (IOT)	20	20	20	80	-		-	100

Subject Code	Subject Name	Credits
ISDO8014	Internet of Things (IOT)	3
Course objective	1. To teach fundamentals of IoT 2. To study data and knowledge management and use of devices in IoT technology. 3. To understand IoT architecture and Integration of embedded devices with IoT 4. To understand concept of IoT. 5. To learn designing of industrial internet systems. 6. To study overview of Android/ IOS app development tools and Internet of Everything	
Course Outcome	Students will be able to- 1. Demonstrate the knowledge of operation of IoT architecture 2. Identify the various technologies for implementing IoT 3. Discuss various communication Technologies used in IoT 4. Discuss various communication models and protocols used in IoT 5. Discuss about the role of cloud computing in IoT 6. Illustrate the application of IoT in Industrial Automation and identify Real World Design Constraints.	

Details of Syllabus:

Module	Content	Hrs.	CO Mapping
1	**Introduction to Internet of Things: An Overview** Introduction – Definition and characteristics of IoT, Physical design of IoT- Things in IoT, IoT protocol, Logical design of IoT – IoT functional blocks, IoT Communication Models, IoT communication APIs.	04	CO1
2	**IoT Enabling Technology** Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems. **IOT Levels and Deployment Templates.**	04	CO2
3	**Introduction to Communication Technologies** 802.15.4, ZigBee, BLE, WiFi, LORA, GSM basic protocol , topologies, data rate, range, power, computations/bandwidth, QoS	10	CO3
4	**Communication Model and Protocols** M2M vs IOT, Resource Management, Registration, Discovery Data Exchange Formats - XML & JSON, MQTT Protocol, RESTFul Architecture, HTTP REST Model, CoAP Protocol	09	CO4
5	**Basics of Cloud Computing** Cloud Based Architecture, Basics of Virtualization º Specific Characteristics that Define a Cloud, Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) Cloud Delivery Models, Public Cloud, Private Cloud, Hybrid Cloud and Community Cloud Deployment Models, Benefits, Challenges and Risks of Cloud Computing Platforms and Cloud Services	06	CO5
6	**Case Studies of IOT** Home (Smart Lighting and Intrusion detection), Cities (Smart Parking, Garbage collection), Environment (Pollution detection, Forest Fire Detection), Power (Smart Grid), Retail (Inventory Management), Logistics (Fleet Tracking) Industry (Machine Diagnosis & Prognosis), Health (Monitoring and Detection), Agriculture (Green House Monitoring, Animal Husbandry.	06	CO6

Internal 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.

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.

Text Books:

1. Vijay Madisetti and Arshdeep Bahga, –Internet of Things (A Hands-on-Approach)‖, 1st Edition, VPT, 2014.
2. Cloud Computing Black Book Edition-2014 by Jagannath Kallakurchi Wiley India

Reference Books:

1. Francis DaCosta, –Rethinking the Internet of Things: A Scalable Approach to Connecting Everything‖, 1st Edition, Apress Publications, 2013
2. Wimer Hazenberg, Menno Huisman and Sara Cordoba Rubino, –Meta Products: Building the Internet of Things‖, BIS publisher

Sub code	Subject Name	Teaching Scheme (Hrs)			Credit Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
ISDOC8015	**Advanced Biomedical Instrumentation**	3	-	-	3	-	-	**3**

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					
ISDOC8015	Advanced Biomedical Instrumentation	20	20	20	80	-	-	-	**100**

Subject Code	**Subject Name**	**Credits**
ISDOC8015	**Advanced Biomedical Instrumentation**	**3**
Prerequisite	• Students should have knowledge about anatomy and physiology of human body • Students should possess knowledge of various bio-signals and their basic measurement methods • Students should be aware of basic principle of working of medical imaging techniques	
Course Objectives	1. To make students understand the working principle and application of various Advanced Biomedical Instruments used in Biomedical field 2. To make students understand the working and applications of imaging techniques in depth.	
Course Outcomes	The students will be able to- 1. Identify various Bio-potential with their specifications, design signal conditioning for the same and perform their measurements. 2. Discuss various prosthetic devices and to identify their parameters for proper operation. 3. Explain the principle and working of various patient monitoring and telemetry systems. 4. Distinguish between the various medical imaging techniques based on the principles and concepts involved in them. 5. Discuss the applications of fibre optics and lasers in Biomedical. 6. Describe the significance of radiation, electrical and fire safety in biomedical measurement.	

Module	Topics	Hrs.	CO Mapping
1	**Introduction to Bio-potential Measurement:** Measurement of membrane potentials, Bio-potential amplifiers, ECG, EEG and EMG measurements, Design of ECG, EEG and EMG signal conditioning circuit.	06	CO1
2	**Prosthetic devices:** Pacemakers – types and constructional details, Implantable defibrillators, Cochlear implants – principle, working and construction, Retinal implants - principle, working and construction, Wearable Artificial Kidney, Functional electrical stimulator (FES)	08	CO2
3	**Patient monitoring system:** Bedside monitor, Central Nurse station, Drug delivery system with instrumentation, Telemetry system	03	CO3
4	**Advanced Medical Imaging:** Computed Tomography (CT) - Details of Acquisition, Digital image reconstruction and display, Magnetic resonance imaging (MRI) – image acquisition and reconstruction techniques, Nuclear Imaging – nuclear radiation detectors, rectilinear scanner, gamma camera, positron emission tomography (PET), single photon emission computer tomography (SPECT)	10	CO4
5	**Fibre optics and Lasers for Biomedical applications:** Optical Sources and Detectors: Introduction, LED's, LASER diodes, Photo detectors – PIN photo diode, avalanche photo diode. Introduction to Fibre Couplers and Connectors, Lasers and its types, properties of lasers and interaction with tissues, Basic endoscope and laparoscope system.	08	CO5
6	**Radiation, Electrical and Fire Safety:** Radiation safety, Safety precautions, Hazardous effects of radiation, allowed levels of radiation, sources of shocks, macro & micro shocks, monitoring and interrupting the operation from leakage current - Elements of fire, causes of fire & fire protection.	04	CO6

Internal 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.

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.

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
4) Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, PHI/Pearson Education, 4th edition, 2001.

Reference Books:

1) Richard Aston, “Principles of Biomedical Instrumentation and Instruments”, PH, 1991.
2) John E Hall, Gyton’s Medical Physiology, 12th edition, 2011
3) L. E. Baker L. A. Geddes, “Principles of Applied Biomedical Instrumentation”, John Wiley and Sons, 3rd Edition, 1991.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC8021	Advanced Digital Signal Processing	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC8021	Advanced Digital Signal Processing	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC8021	Advanced Digital Signal Processing	3
Course Objectives	1. To introduce the basic concepts of multi-rate signal processing. 2. To familiarize with linear prediction and power spectrum estimation techniques. 3. Ability to apply the time-frequency transforms in signal analysis. 4. To understand the basic concepts of Digital Signal Processor and adaptive filtering for practical applications.	
Course Outcomes	Students will be able to: 1. Describe the basic concepts of multi-rate DSP. 2. Apply linear prediction algorithms in real-time applications. 3. Estimate the power spectrum for random signals. 4. Apply adaptive filters in noise and echo cancellation applications. 5. Analyze the signals in time-frequency domain using STFT and Wavelets. 6. Implement real-time signal processing applications using Digital Signal Processor.	

Module	Contents	Hrs.	CO Mapping
1.	**Multi-rate digital signal processing**: Basic multi-rate operation (up sampling, down sampling), Efficient structures for decimation and interpolation, Decimation and interpolation with polyphase filters, non-integer sampling rate conversion, Efficient multi-rate filtering Applications.	06	CO1
2.	**Linear prediction:** Innovations Representation of a Stationary Random Process, Forward and Backward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters.	07	CO2
3.	**Power spectral estimation**: Periodogram based nonparametric methods: Periodogram, Bartlett's method, Welch's method, Blackman-Tukey method Parametric methods for power spectrum estimation: ARMA modelling, Yule- Walker equation and solution.	06	CO3
4.	**Adaptive filtering**: Principles of Adaptive filtering, LMS and RMS Algorithms, Applications in noise and echo cancellation, Homomorphic Signal Processing, homomorphic system for convolution, properties of complex-spectrum, Applications of homomorphic deconvolution.	07	CO4
5.	**Time-frequency Analysis**: Fourier Transform: Its power and Limitations, Short Time Fourier Transform, The Gabor Transform, Discrete Time Fourier Transform and filter banks, Continuous Wavelet Transform, Discrete Wavelet Transform, Haar Wavelet, Daubechies Wavelets.	06	CO5
6.	**Digital Signal Processor** (TMS320C67XX, ADSP-21XX, SHARC): Introduction to fixed point and floating-point DSP processor, Features of DSP processor, architecture of DSP processor, architecture features: computational units, bus architecture memory, data addressing, address generation unit, program control, program sequencer, pipeling, interrupts, features of external interfacing, on-chip peripherals, hardware timers, host interface port, clock generators, SPORT.	07	CO6

Internal 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.

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.

Text Books:

1. J. Proakis , Charles M. Rader, Fuyun Ling, Christopher L. Nikias, „Advanced Digital Signal Processing“, (Macmillan Coll Div) (1992)
2. Glenn Zelniker, Fred J. Taylor, „Advanced Digital Signal Processing“, (CRC Press) (1994)

Reference Books:

1. A.V.Oppenheim and R.W.Schafer, "Discrete time Signal Processing", (Prentice Hall) (1992)
2. Haykins, "Adaptive Filter theory", (Prentice Hall) (1986)
3. Dr. Rulph Chassaing , “ Digital Signal Processing and Application with the TMS 320c6713 and TMS 320c6716”, Wilay Publication.
4. Raghuveer. M. Rao, Ajit S.Bopardikar, Wavelet Transforms, Introduction to Theory and applications, Pearson Education, Asia, 2000.
5. Introduction to Wavelets and Wavelet Transform: C. S. Burrus, Ramesh and A. Gopinath, Prentice Hall Inc.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC8022	Building Automation	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC8022	Building Automation	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC8022	Building Automation	3
Course Objectives	1. To brief students with origin and evolution of building automation. 2. To train them with architecture and operation of BAS. 3. To facilitate them for designing automation system for intelligent building. 4. Develop technique for preparation of various documents required for design requirement of safety building.	
Course Outcomes	The students will be able to: 1. Explain the concept of intelligent building and BAS. 2. Select the hardware and design of HVAC in building automation system. 3. Discuss the concept of energy management system. 4. Design and implement the safety system for building. 5. Design security and video management system for building. 6. Integrate the different system in BAS.	

Module	Contents	Hrs.	CO Mapping
1.	**Introduction to intelligent buildings and BAS:** Definitions of intelligent building, Intelligent architecture and structure, Facilities management vs. intelligent buildings, Technology systems and evolution of intelligent buildings. **Building Automation System:** Features, Characteristics, Drawbacks of Building Automation system. Various Systems of Building Automation – Building Management System, Energy Management System, Security System, Safety System, Video Management System.	05	CO1
2.	**HVAC system:** Introduction, HVAC, Components of HVAC, AHU, Control of CAV systems, Control of VAV systems, AC Plant Room – Concept, Components, Refrigeration Cycle Working Principle, Chiller Sequencing, AC Plant Sequencing. Feedback Control Loops, optimal control methods used for HVAC systems, Direct Digital Control (DDC) Psychrometry –Concept, ASHRAE Psychrometric Chart, Meaning of Various Terms – DBT, WBT, ST, RH, DPT, Sensible & Latent Cooling & Heating, Numerical.	10	CO2
3.	**Energy Management System:** Concept, Energy Meters, Types, Meter Networking, Monitoring Energy Parameters, Analysis of Power Quality – Instantaneous Power, Active Power, Reactive Power, Power Factor, Voltage, Current. Effect of Power Quality on Energy Consumption, Energy Reports, Energy Conservation, Importance of Energy Saving.	04	CO3
4.	**Safety Systems:** Introduction, Fire –Meaning, Fire Development Stages, Fire Sensors & Detectors, Detector Placement, and Detectors Required for Various Applications. Fire Extinguishing Principles, Fire Extinguishers & Its Classification. Fire Alarm System – Controllers, Components, Features, Concept of Fire Loop & Fire Devices, 2-Wire & 4-Wire Loops, Working Principle, System Description, Pre-alarm, Alarm, Trouble, Fault, Differences, Cable Selection, Installation Guidelines Best Installation Practices, NFPA and IS2189 standards	08	CO4
5.	**Security Systems:** Introduction, Access Control – Concept, Components, Types, Features, Card Technologies, Protocols, Controllers, Concept of Antipassback, Biometrics, Cabling, Intrusion Detection System – Sensors, Working Principle **Video Management:**	08	CO5

	Video Door phone, CCTV Cameras, CCD Camera Basics, Traditional CCTV System, Video Recording, Drawbacks, Digital Video Recording, Features, Functionalities, Digital Vs Analog Recording, Digital Video Management System – Introduction, Features, Advancements & Differences from Earlier Video Techniques, TCP/IP Networking Fundamentals, System Network Load Calculations, Network Design.		
6.	**Integrated Systems:** Introduction, Integration of Building Management System, Energy Management System, Safety System, Security Systems & Video Management, Benefits of Integrated Systems, Challenges, Future Prospects of Integrated Systems.	04	CO6

Internal 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.

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.

Text Books:

1. Shengwei Wang, *"Intelligent Buildings and Building Automation",* 2009.
2. Reinhold A. Carlson, Robert A., Di Giandomenico, *"Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security Access Control, Lighting, Building",* 1991

Reference Books:

1. Roger W. Haines, *"HVAC system Design Handbook",* 2003.
2. National Joint Apprenticeship & Training Committee, *"Building Automation System Integration With Open Protocols: System Integration With Open Protocols",* 2009.
3. John I. Levenhagen and Donald H. Spethmann, *"HVAC Controls and Systems",* 1992.
4. James E.Brumbaugh, *"HVAC fundamentals",* 2004

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC8023	Functional Safety	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC8023	Functional Safety	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC8023	Functional Safety	3
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: 1. Define the role of Safety instrumented system in the industry. 2. Describe steps involved in Safety life cycle 3. Explain process and safety control with SIS technologies. 4. Calculate combined probability for different types of events. 5. Analyse the potential hazards in the process. 6. Determine the Safety integrity level.	

Details of Syllabus:

Prerequisite: Digital Electronics, transducers and Process Control

Module	Contents	Hrs.	CO mapping
1	**Introduction:** Safety Instrumented System (SIS) - need, features, components, difference between basic process control system and SIS, Risk: how to measure risk, risk tolerance, Safety integrity level, safety instrumented functions. Standards and Regulation – HSE-PES, AIChE-CCPS, IEC-61508, IEC 61511 (2-16), 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 Safety Management of Highly Hazardous Chemicals),	05	CO1
2	**Safety life cycle:** 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.	05	CO2
3	**Process Control** – Active / Dynamic, Safety Control – Passive / Dormant, Demand Mode vs. Continuous Mode, Common Cause and Systematic or Functional Failures, **Protection Layers:** prevention and mitigation layers, SIS Technologies: Pneumatic Systems, Relay Systems, Solid State Systems, Microprocessors / PLC (Software based) Systems	05	CO3
4	**Rules of Probability:** Assigning probability to an event, types of events and event combination, combining event probabilities, fault tree analysis, failure rate and probability, simplifications and approximations.	06	CO4
5	**Process Hazard Analysis:** Consequence analysis: Characterization of potential events, dispersion, impacts, occupancy considerations, consequence analysis tools. Likelihood analysis: estimation and statistical analysis, fault propagation, event tree analysis and fault tree analysis, Quantitative layer of protection analysis: multiple initiating events, estimating initiating event frequencies and IPL failure probabilities, HAZOP and SIL calculation and verification.	12	CO5

6	**Determining the Safety Integrity Level (SIL):** Evaluating Risk, Safety Integrity Levels, SIL Determination Method: As Low as Reasonably Practical (ALARP), Risk matrix, Risk Graph, Layers of Protection Analysis (LOPA)	06	CO6

Internal 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.

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.

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.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC8024	Power Plant Instrumentation	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC8024	Power Plant Instrumentation	20	20	20	80	-	-	20	100

Subject Code	Subject Name	Credits
ISDOC8024	Power Plant Instrumentation	3
Course Objectives	1. To create awareness of energy resources and its scenario in India and worldwide. 2. To study the concept of power generation using various resources. 3. To study the role of Instrumentation in power plants. 4. To study and compare various power plants for optimal performance. 5. To acquire students the knowledge about hazards and safety in handling power plants.	
Course Outcomes	The students will be able to: 1.Classify the energy generation resources. 2. Illustrate operation and control of thermal power plant equipment. 3. Select the sites for hydroelectric power plants and explain its operation. 4. Explain the power generation and control of nuclear power plant. 5. Describe the non-conventional energy resources. 6. Compare different types of power plants.	

Details of Syllabus:

Prerequisite: Knowledge of energy resources, types of power plants and power generation.

Module	Contents	Hrs.	CO mapping
1	**Introduction:** Energy sources, their availability, worldwide energy production, energy scenario of India. Introduction to Power generation, load curve, load factor. Classification of energy generation resources.	4	CO1
2	**Thermal Power Plant**- Method of power generation, layout and energy conversion process. Types of Turbines & their control. Boilers and their control. Types of Generators and their control, Types of Pumps and Fans, Material handling system, study of all loops-water, steam, fuel etc. Schematics of Gas turbine and Diesel power plant.	10	CO2
3	**Hydroelectric Power Plant**- Site selection, Estimation electric power to be developed, classification of Hydro power plants. Types of Turbines for hydroelectric power plant, pumped storage plants, storage reservoir plants.	6	CO3
4	**Nuclear Power Plant –** Concept of energy generation from nuclear fission, control of chain reaction, schematics of Nuclear power plant, types of reactors, reactor control, safety measures.	6	CO4
5	**Non-conventional Energy Resources** – **Wind Energy:** Power in wind, wind power conversion, aerodynamics of wind turbine, types of wind turbine and their modes of operation, power control of wind turbines and detection of failure, Betz limit, Pitch & Yaw control, connection of wind mill on power grid, applications of wind energy, safety. **Solar Energy:** Solar resource, solar energy conversion systems. Solar PV technology: Block diagram of PV system, Detection of failure and performance monitoring of PV cell in the array of cells, connection of solar power on power grid, advantages and limitations. Solar thermal energy system: Principle, solar collector and its types, solar concentrator and its types, safety.	9	CO5
6	**Comparison of different types of power plant**: On the basis of Performance, efficiency, site selection, Economics-capital and running, safety. Introduction to Hybrid Power Generation concept. Introduction to Modern Biomass, Bio-fuels, Geothermal energy, Tidal energy and Ocean thermal energy.	4	CO6

The Industrial visit is recommended for understanding of different process loops and functioning of the industry.

Internal 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.

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.

Text Books:

1. P. K. Nag, Power plant engineering, Fourth edition (2017), McGraw Hill Education.
2. K. Krishnaswamy, M. Ponni Bala, Power Plant Instrumentation, Second edition (2013), PHI.
3. R. K. Rajput, A Textbook of Power Plant Engineering,Fifth edition (2016), Laxmi Publications.

Reference Books:

1. S.C.Arora, A.V.Domkundwar, Power Plant Engg.,(2013),Dhanpat Rai & Co.
2. B. H. Khan, Non-conventional energy resources, McGraw Hill, New Delhi.
3. Chetan Singh Solanki, Renewable energy Technology, Prentice Hall Publication.
4. S. P. Sukhatme, Solar Energy, Tata McGraw Hill, New Delhi.
5. G. D. Rai, Nonconventional energy sources, Khanna Publication.
6. Dickinson & Cheremision off, Solar Energy Technology vol I & II.
7. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook (2001), John Wiley & Sons, ISBN: 0471489972.
8. James Manwell, J. F. Manwell, J. G. McGowan, Wind Energy Explained: Theory, Design and Application (2002), John Wiley and Sons Ltd, ISBN: 0471499722
9. Z. Lubosny, Wind Turbine Operation in Electric Power Systems (2003), Springer-Verlag New York, Inc ; ISBN: 354040340X.
10. Z. Lubosny, Wind Turbine Operation in Electric Power Systems (2003), Springer-Verlag New York, Inc ; ISBN: 354040340X.
11. G.F. Gilman, Boiler Control Systems Engineering, 2005, ISA Publication.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC8025	Optimal Control System	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISDOC8025	Optimal Control System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC8025	Optimal Control System	3
Course Objectives	1. To make students understand the optimal control problems their types and how to solve them by calculus of variation and dynamic programming approaches. 5. To make student to understand the linear regulator and tracking systems, discrete time optimal control systems.	
Course Outcomes	The students will be able to 1. Identify various optimal control problems with performance measure with minimum time, minimum fuel, minimum energy, terminal cost and general problems. 2. Use the principle of calculus of variation to determine a function that minimizes a specified functional. 3. Derive the necessary conditions for optimal control problem, and optimal law for the linear regulator problem. 4. Understand applications of linear quadratic regulator and tracking systems. 5. Apply variational calculus for solving discrete linear quadratic regulator and tracking problems. 6. Study the method of dynamic programming leads to a functional equation that is amenable to solution by using simulation software.	

Details of Syllabus:

Prerequisite: Knowledge of Linear algebra, Fourier Series, and differential calculus.

Module	Contents	Hrs.	CO mapping
1	**Introduction**: Formulation of optimal control problem, Performance measure, selecting a performance measure.	04	**CO1**
2	**Calculus of variation I** Fundamental concepts: functional, Linearity of functional, closeness, increment, variation, maxima and minima of functional, fundamental theorem of calculus of variation. Extremum of functional of single function: fixed and free end point problems, Extremum of functional of several independent function: fixed and free end point problems	08	**CO2**
3	**Calculus of variation II** Constrained extremum of functions: elimination method, Lagrange multiplier method Constrained extremum of functionals: point constraint, differential equation constraints, isoperimetric constraints. The Variational approach to optimal control problems: necessary conditions for optimal control for different boundary conditions	08	**CO3**
4	**Linear Regulator and Tacking Systems:** Linear Quadratic Regulator (LQR): Finite time LQR and infinite time LQR Linear Quadratic Tracking Systems: Finite and infinite time Cases	06	**CO4**
5	**Discrete time Optimal control systems**: variational calculus for discrete time systems, Discrete time LQR and tracking systems	05	**CO5**
6	**Dynamic Programming**: Principle of optimality, application of principle of optimality to decision making, dynamic programming applied to routing problem, Hamilton-Jacobi-Bellman (HJB) equation, LQR system using HJB equation	08	**CO6**

Internal 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.

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.

Text Books.

1. D. S. Naidu, *Optimal Control System*, CRC Press LLC - 2003,
2. D. E. Kirk, *Optimal Control Theory - An Introduction*, Dover Publication, New York – 1998.

Reference Books

1. B.D.O. Anderson and J.B. Moore. *Optimal Control, Linear Quadratic Methods*. Prentice-Hall Inc., Englewood Cliffs, NJ, 1989.
2. H. Kwakernaak and R. Sivan. *Linear Optimal Control Systems*. Wiley-Interscience, New York, 1972.
3. A. Sage. *Optimum systems control*. Prentice Hall, 2nd edition, 1977
4. F. L. Lewis and V. L. Syrmos. *Optimal Control theory*. Wiley Interscience, 2nd edition, 1995.
5. R. D. Robinett, D. G. Wilson, G. R. Eisler, and J. E. Hurtado. *Applied dynamic programming for optimization of dynamical systems*. Advances in Design and Control. SIAM, Philadelphia, 2005.
6. K. Ogata, Discrete Time Control System, Second Edition, PHI, Inc. 1995.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL801	Instrument and System Design Lab Practice	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End sem exam	Term work	Pract. And oral	Oral	Total
		Test1	Test2	Avg.					
ISL801	Instrument and System Design Lab Practice	-	-	-	-	25	-	25	50

Subject Code	Subject Name	Credits
ISL801	Instrument and System Design Lab Practice	1
Course objective	1. To impart knowledge of selection and design considerations of transducers along with its calibration techniques. 1. To make the students capable of sizing the control valve. 2. To give the students' knowledge about the types, sizing of control panels and standards. 3. To make the students capable to apply knowledge to design electronic product, control room layout and its environment. 4. To give the students a comprehension of the aspects of reliability engineering.	
Course Outcome	The students will able to: 1. Calculate performance characteristics of a given transducer and calibrate transducers. 2. Select and size the control valves and actuators. 3. Estimate valve noise and predict cavitation. 4. Apply knowledge to design the control panels and control room. 5. Design electronic products and enclosures. 6. Calculate Reliability engineering terms	

Syllabus: Same as that of Subject ISC801 Instrument and System Design.

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	To study the performance characteristics of transducer/ instrument	**CO1**
2	To calibrate temperature, flow, pressure or level transducers	**CO1**
3	To calculate Cv of a given valve (use Cv characteristic set up)	**CO2**
4	To design the control panel for any one application.	**CO4**
5	To design the layout of a control room.	**CO4**
6	Assignment on design of transducers.	**CO1**
7	Assignment on valve sizing for liquid services and gas/vapors.	**CO2**
8	Assignment on valve sizing for flashing, and mixed flow services	**CO2**
9	Assignment on estimation of control valve Noise and Cavitations	**CO3**
10	Assignment: examples on actuator sizing	**CO2**
11	Assignment on control panel design	**CO4**
12	Assignment on electronic product design and enclosure design	**CO5**
13	Assignment on reliability engineering.	**CO6**
14	Assignment on control room design and its environment	**CO4**

Any other experiments/assignments based on syllabus which will help students to understand topic/concept.

Note:

1) Minimum of four experiments and four assignments can be performed during the semester for term work and oral examination.
2) Industry visit is advised to understand the Instrument and System Design subject.

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

Term Work:
Term work shall consist of minimum four experiments and four assignments.

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

Laboratory work (Experiments) : 10 Marks
Laboratory work (Assignments) : 10 Marks
Attendance : 5 Marks

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL8021	Digital Control System Lab practice	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL802	Digital Control System Lab practice	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL802	Digital Control System	1
Course Objectives	1. The students should be able to determine response of ZOH and FOH 2. The students should be able to discretize continuous data system. 3. The students will be able to represent given system into different canonical form. 4. The students should able to determine state transition matrix 2. Students can be able to design controller and observer	
Course Outcomes	Students will be able to – 1. Compare the response with reconstruction due to ZOH and FOH. 2. Discretize the analog systems and signals with different methods 3. Verify the controllability and observability of systems 4. Demonstrate their knowledge to obtain different canonical forms analytically and verify using simulation software. 5. Determine state transition matrix using simulation software and verify the results analytically 6. Design controller and observer for the given system	

Syllabus: Same as that of Subject ISDOC8011Digital Control System.

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	To determine response of zero order hold and first order hold using simulation software	CO1
2.	Mapping from S- plane to Z-plane analytically and verification using simulation software	CO2
3.	Discretization of continuous data system using i) Step invariance method, ii) Impulse invariance method, and iii) Bilinear transformations, analytically and verification using simulation software	CO2
4.	To check controllability and observability of a given system analytically and verify the result using simulation software.	CO3
5.	To represent given system in different canonical forms, analytically and verification using simulation software	CO4
6.	To determine pulse transfer function of a given system analytically and its verification using simulation software	CO4
7.	Determination of state transition matrix analytically and its verification using simulation software	CO5
8.	To design the controller by any method	CO6
9.	To design an observer by any method	CO6

Any other experiment based on syllabus which will help students to understand topic/concept.

Note: Student can use any simulation software.

Practical and Oral Examination:

Practical and Oral examination will be based on entire syllabus of **ISDOC 8011** Digital Control System.

Term Work:

Term work shall consist of minimum 08 experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments): 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.

Course code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL8022	Expert System Lab	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Theory (100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment (20)			End sem Exam				
		Test 1	Test2	Avg.					
ISL8022	Expert System Lab	-	-	-	-	25	25	-	50

Subject Code	Subject Name	credits
ISL8022	Expert System	3
Course objective	1. To provide an understanding on the fundamentals of Artificial Intelligence and Expert System. 2. To provide an understanding on the fundamentals of neural network. 3. To provide an understanding on the fundamentals of fuzzy systems. 4. To provide an understanding of Neuro fuzzy system. 5. To provide an understanding of applications based on Artificial Intelligence and Expert System.	
Course Outcome	The students will able to 1. Develop programs for various neural networks. 2. Write program for advance neural networks. 3. Simulate fuzzy inference system. 4. Develop programs for neuro fuzzy systems. 5. Demonstrate working of AI/Expert systems in Process control, Electrical Engineering. 6. Demonstrate working of AI/Expert systems in Speech processing, medical diagnosis.	

Syllabus: Same as that of Subject ISDOC8012 Expert System.

List of the Laboratory Experiments:

Sr. No.	Contents	CO Mapping
1.	Write a python program to construct and simulate single input neurons. Simulate with different weights, transfer functions, etc.	CO1
2.	Write a python program to construct and simulate multi-input neurons. Simulate with different weights, transfer functions, etc.	CO1
3.	Write a python program for back propagation algorithm.	CO1
4.	Write a python program to simulate recurrent neural network.	CO2
5.	Write a python program to simulate convolutional neural network.	CO2
6.	Write a python program to simulate mamdani fuzzy inference system.	CO3
7.	Write a python program to simulate sugeno fuzzy inference system.	CO3
8.	Write a python program to simulate neuro fuzzy systems.	CO4
9.	Case study or mini project on application of AI/Expert systems in Process control.	CO5
10.	Case study or mini project on application of AI/Expert systems in Electrical Engineering.	CO5
11.	Case study or mini project on application of AI/Expert systems in Speech processing.	CO6
12.	Case study or mini project on application of AI/Expert systems in medical diagnosis.	CO6

Any other experiment based on syllabus which will help students to understand topic/concept.

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

Term Work:
Term work shall consist of minimum 8 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 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.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL8023	Digital Image Processing Lab	3	-	-	3	-	-	3

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL8023	Digital Image Processing Lab	20	20	20	80	25	-	25	150

Subject Code	Subject Name	Credits
ISL8023	Digital Image Processing	1
Course Objectives	1. To introduce the basic elements of digital image processing. 2. To familiarize with 2-D Transforms of digital images. 3. Ability to use image enhancement and segmentation techniques. 4. To analyze image compression and object recognition algorithms.	
Course Outcomes	Students will be able to: 1. Interpret the basic elements of digital image processing. 2. Analyze digital images using 2-D transforms. 3. Apply spatial filtering and image enhancement techniques in the frequency domain. 4. Analyze image segmentation techniques. 5. Apply different image compression techniques. 6. Recognize and classify objects and patterns in digital images.	

List of Experiments:

Sr. No.	Contents	CO Mapping
1.	To perform basic operations on images.	CO1
2.	To perform conversion between color spaces.	CO1
3.	To perform 2D DFT/ DCT of images	CO2
4.	To perform histogram equalization.	CO3
5.	To perform image filtering in spatial domain	CO3
6.	To perform image filtering in frequency domain.	CO3
7.	To perform edge detection using various masks	CO4

8.	To perform global and adaptive thresholding	CO4
9.	To perform image compression using DCT / Wavelet transform.	CO5
10.	To apply morphological operators on an image	C06

Any other experiment based on syllabus which will help students to understand topic/concept.

Practical and Oral Examination:

Practical and Oral examination will be based on entire syllabus of **ISDOC8013** Digital Image Processing subject

Term Work:

Term work shall consist of minimum 08 experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 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.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract/Oral.**	**Tut.**	**Total**
ISL8024	Internet of Things- Lab	-	2	-	-	1	-	1

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment (20)			End Sem Exam				
		Test1	Test2	Avg.					
ISL8024	Internet of Things- Lab	-	-	-	-	25	-	25	50

Subject Code	**Subject Name**	**Credits**
ISL8024	**Internet of Things- Lab**	**1**
Course objectives	**1.** To impart knowledge about fundamentals of IoT **2.** To describe data and knowledge management and use of devices in IoT technology. **3.** To give knowledge of IoT architecture and Integration of embedded devices with IoT **4.** To explain the concept of IIoT. **5.** To impart knowledge about designing of industrial internet systems. **6.** To describe overview of Android/ IOS app development tools and Internet of Everything	
Course Outcomes	The students will be able to: 1. Describe Fundamentals of IoT and make use of microcontroller based embedded platforms in IOT. 2. Identify IoT enabling technologies and make use of microprocessor based embedded platforms in IOT. 3. Apply wireless technology for exchange of data. 4. Make use of Cloud platform to upload and analyse any sensor data and understand communication protocols used in IoT. 5. Use of Devices, Gateways and Data Management in IoT. 6. Use the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis.	

Syllabus: Same as that of Subject ISDOC8014 **Internet of Things**

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Assignment on Fundamentals and overview of IoT	CO1
2	Assignment on IoT enabling technologies	CO2
3	Introduction to Arduino platform and programming	CO1, CO5
4	Interfacing LDR sensor and LED with Arduino	CO1, CO5
5	Interfacing accelerometer sensor with Arduino	CO1, CO5
6	Interfacing gyroscope sensor with Arduino	CO1, CO5
7	Interfacing Arduino to Zigbee module	CO1, CO3
8	Interfacing Arduino to GSM module	CO1, CO3
9	Interfacing Arduino to Bluetooth Module	CO1, CO3
10	Assignment on communication protocols in IoT	CO4
11	Introduction to Raspberry PI platform and python programming	CO2
12	Interfacing sensors to Raspberry PI	CO2, CO5
13	Setup a cloud platform to log the data	CO4
14	Log Data using Raspberry PI and upload to the cloud platform	CO4, CO5
15	Design an IOT based system	CO6

Any additional experiments/assignments based on syllabus which will help students to understand topic/concept.

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

Term Work:
Term work shall consist of minimum 8 experiments and two assignments. The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

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

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL8025	Advanced Biomedical Instrumentation Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISL8025	Advanced Biomedical Instrumentation Lab	--	--	--	--	25	-	25	50

Subject Code	Subject Name	Credits
ISL8025	Advanced Biomedical Instrumentation Lab	1
Course objective	1. To make students perform experiments based on the principle and working of various Biomedical Instruments used for Bio-potential measurements 2. To develop skills in the design of various biomedical instruments used in diagnosis and life-support.	
Course Outcome	Students will be able to- 1. Design ECG, EEG, EMG amplifier. 2. Design and/ or simulate prosthetic devices circuitry. 3. Design circuitry required for patient monitoring systems and telemetry 4. Distinguish between the various medical imaging techniques by comparing, principle and concept involved in each of the technique 5. Use fiber optics for healthcare application. 6. Describe the significance of electrical safety in biomedical measurement.	

Syllabus: Same as that of Subject ISDOC8015 Advanced Biomedical Instrumentation.

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	Design and implement ECG amplifier circuitry.	**CO1**
2.	Design and implement EEG amplifier circuitry.	**CO1**
3.	Design and implement EMG Quantification circuit.	**CO1**
4.	Design Cochlear implant circuitry.	**CO2**
5.	Simulate Hemodialysis machine.	**CO2**
6.	Design the multiplexing circuitry for a bedside monitor.	**CO3**
7.	Design and / or simulate patient drug delivery system.	**CO3**
8.	Design and/or simulate ECG/EMG telemetry system	**CO3**
9.	Assignment on image reconstruction of CT.	**CO4**
10.	Distinguish imaging techniques such as MRI, PET and SPECT.	**CO4**
11.	Simulate characteristics of optical fiber.	**CO5**
12.	Validate characteristics of photo detector	**CO5**
13.	Assignment on Radiation, Electrical Safety and Fire safety in biomedical.	**CO6**

Any other experiment based on syllabus of Advanced Biomedical Instrumentation, which will help students to understand topic/concept.

Practical and Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum 06 experiments from the above given list and 02 assignments. (All six COs must be covered)
Hospital visit is recommended

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments/ Assignments) :10 Marks
Laboratory work (Journal/visit) :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.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISP801	Major Project – II	--	12#	--	--	6	--	6

# Indicates workload of Learner (Not Faculty)

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISP801	Major Project – II	--	--	--	--	50	--	100	150

Subject Code	Subject Name	Credits
ISP801	Major Project – II	3
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 9 Demonstrate project management principles during project work.	

Guidelines for Major Project

- Students should form groups with minimum 2(two) and not more than 4 (four)
- Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;

    - Marks awarded by guide/supervisor based on log book : 15
    - Marks awarded by review committee : 15
    - Quality of Project report : 20

Review/progress monitoring committee may consider following points for assessment.

- In VIII semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Assessment criteria of Major Project-II

Major Project-II shall be assessed based on following criteria;

1. Cost effectiveness and Societal impact
2. Full functioning of working model as per stated requirements
3. Effective use of skill sets
4. Effective use of standard engineering norms
5. Contribution of an individual's as member or leader
6. Clarity in written and oral communication

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.

- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.

- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Major Project shall be assessed based on following points:

1 Quality of problem and Clarity

2 Innovativeness in solutions

3 Cost effectiveness and Societal impact

4 Full functioning of working model as per stated requirements

5 Effective use of skill sets

6 Effective use of standard engineering norms

7 Contribution of an individuals as member or leader

8 Clarity in written and oral communication

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